Figure 1 The Rendering Problem

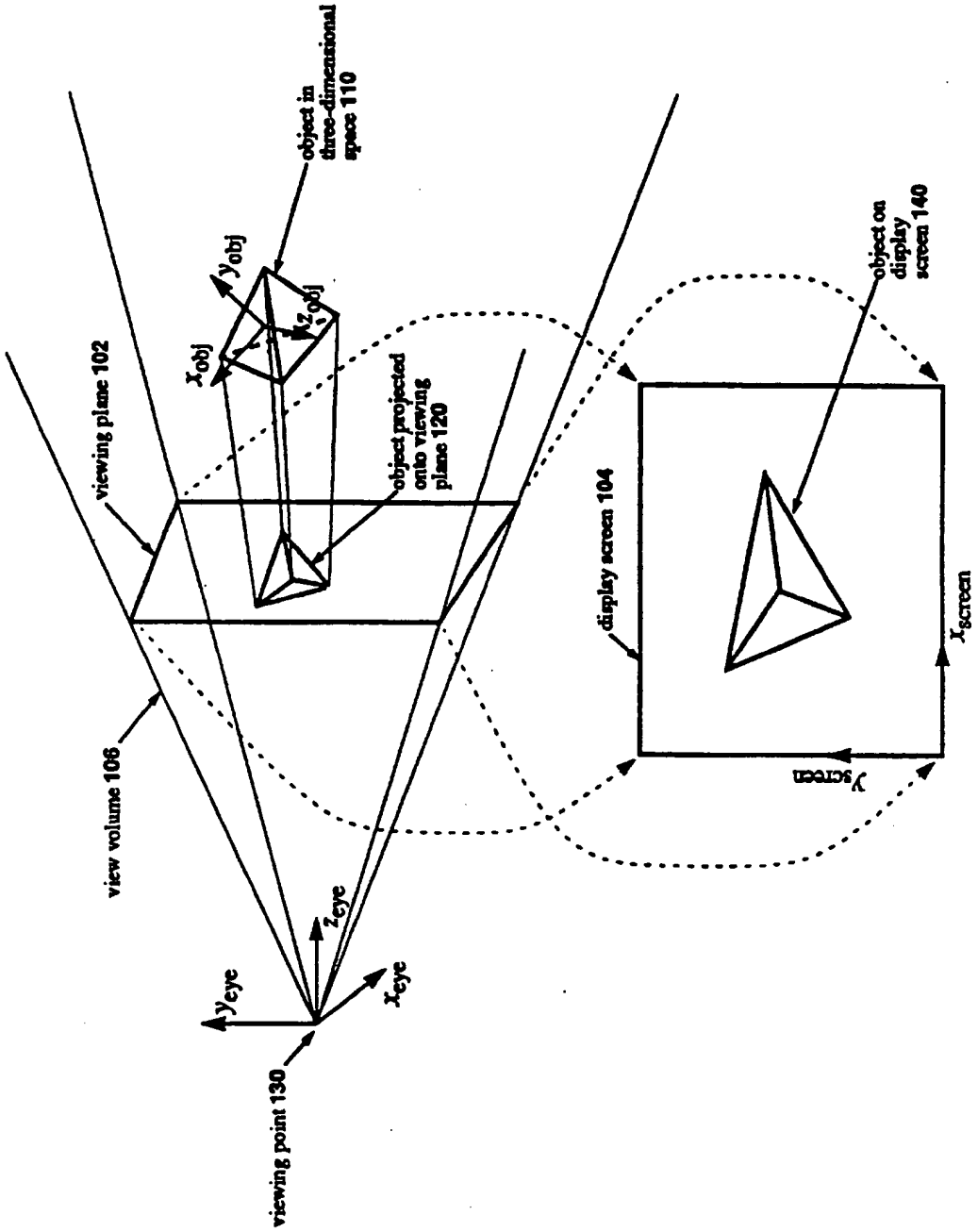


Figure 2 Generic 3D Rendering Pipeline

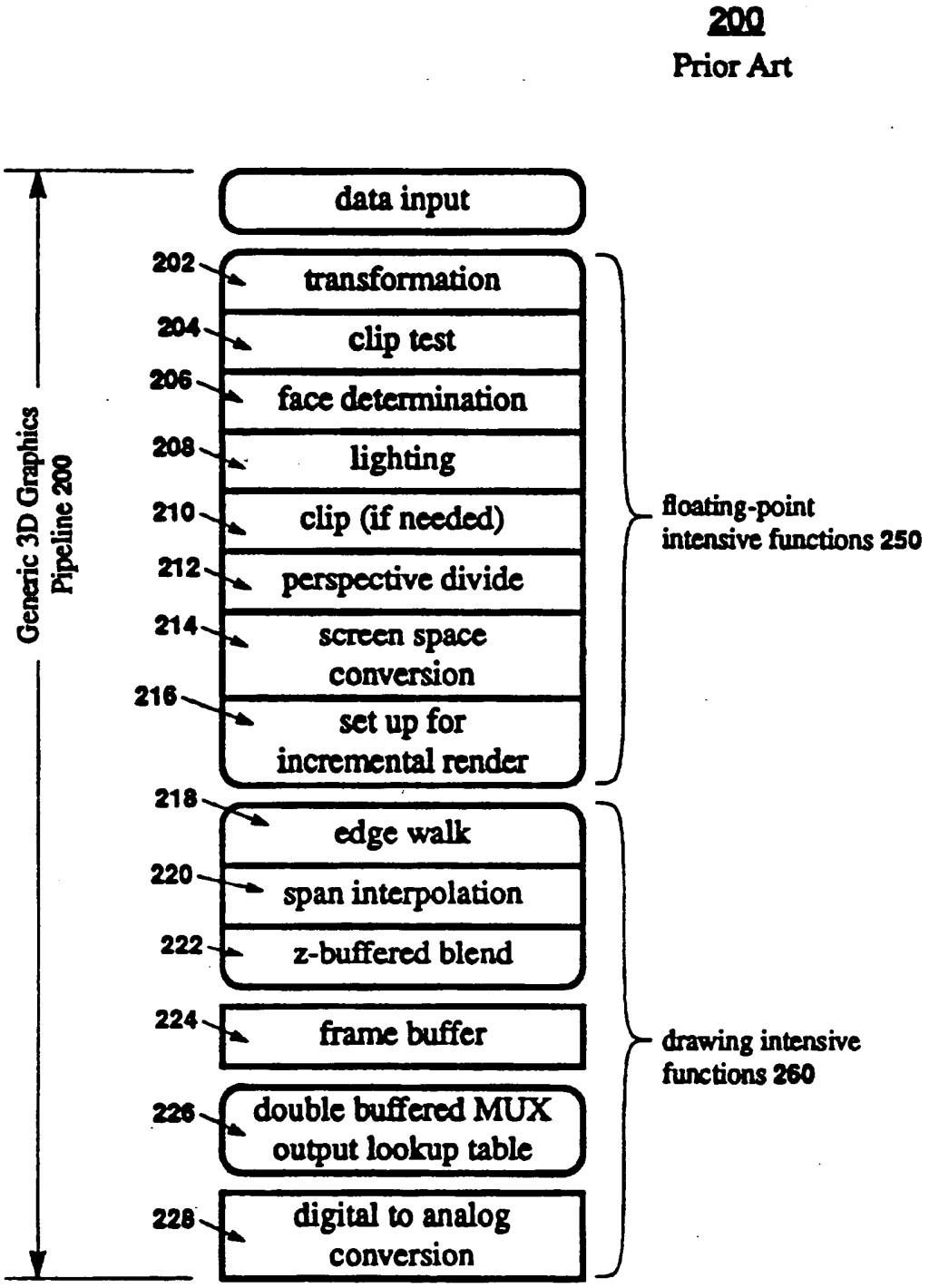


Figure 3 Generic 3D Rendering Method

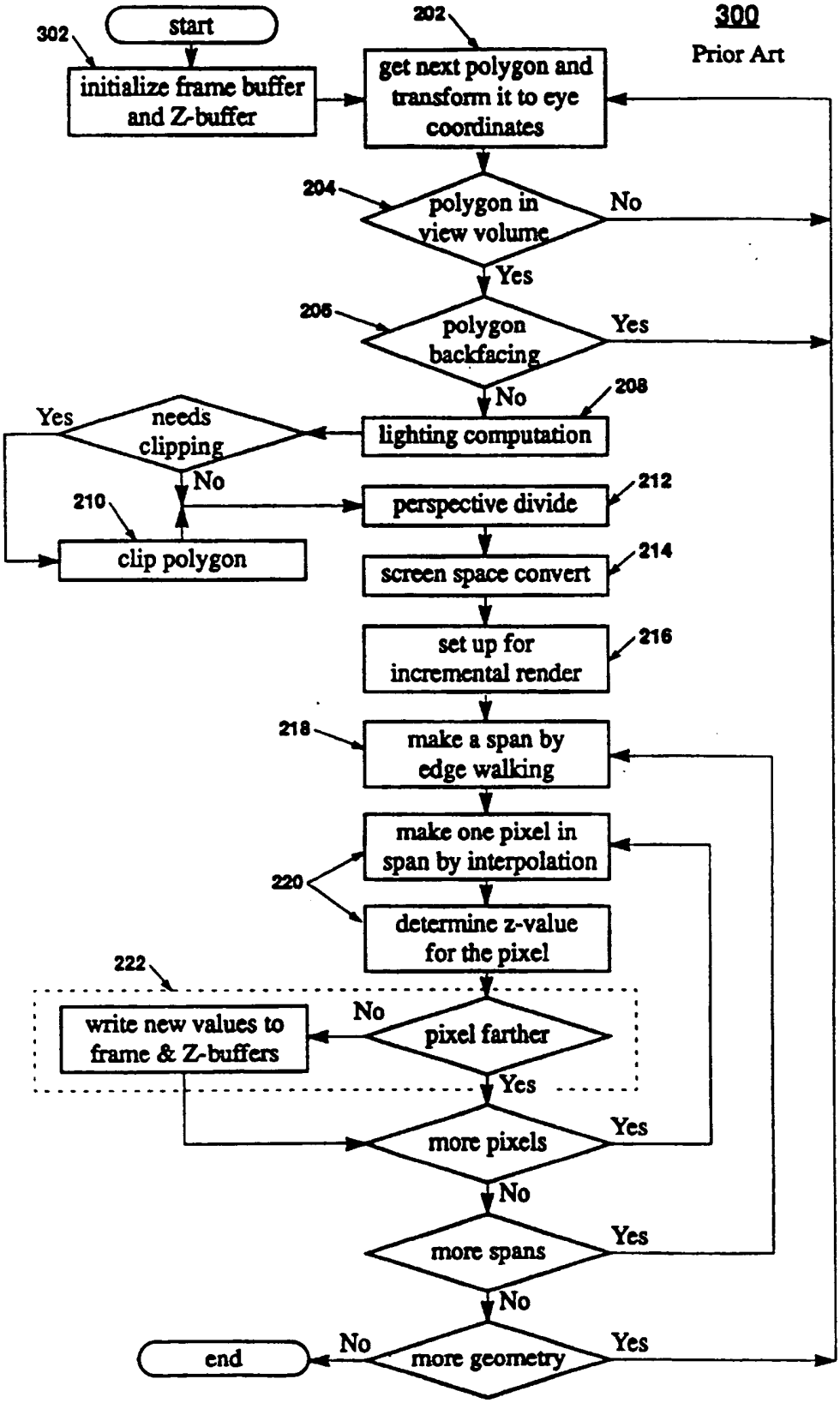


Figure 4 Span Sorting Rendering Pipeline

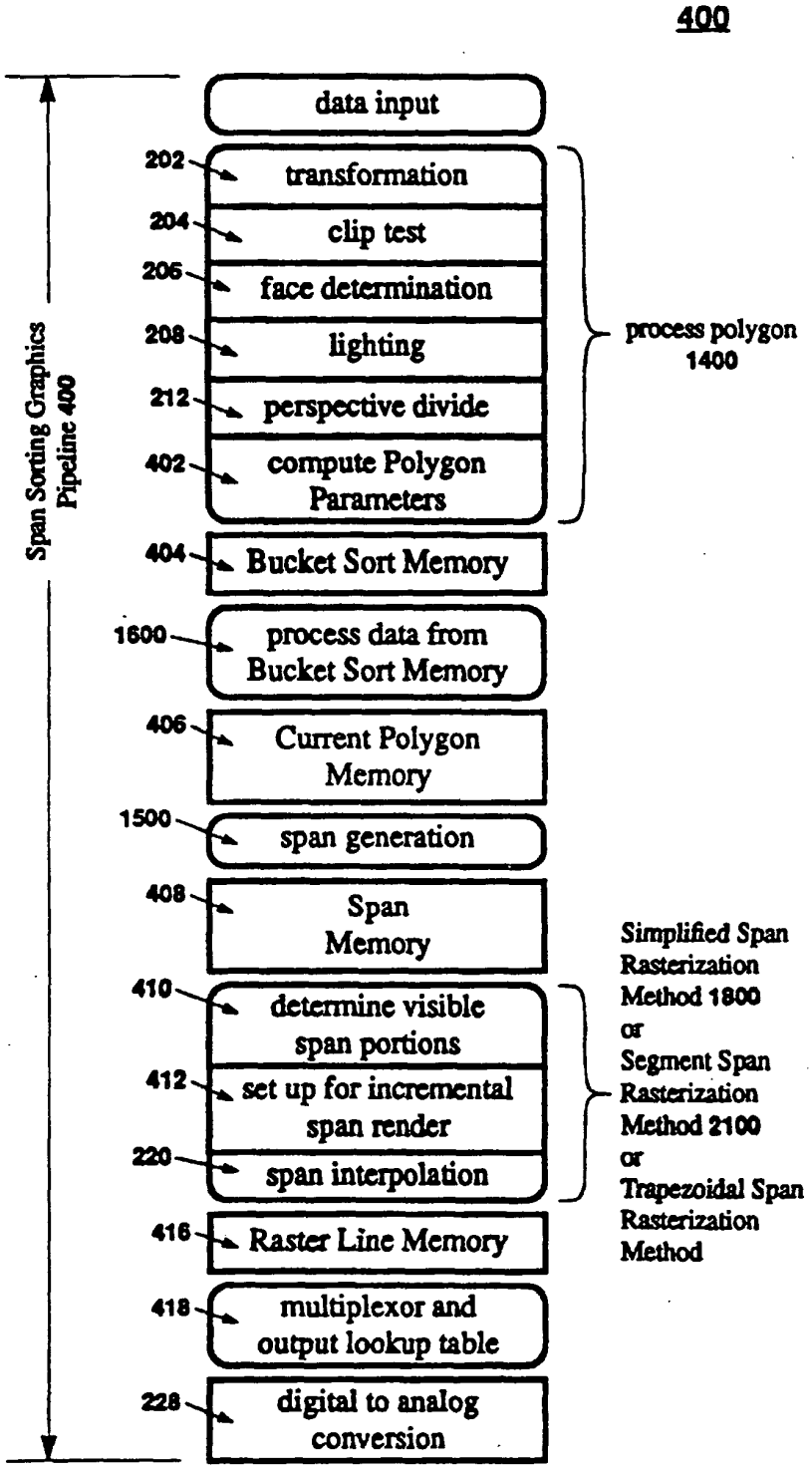


Figure 5 Span Sorting Renderer Architecture

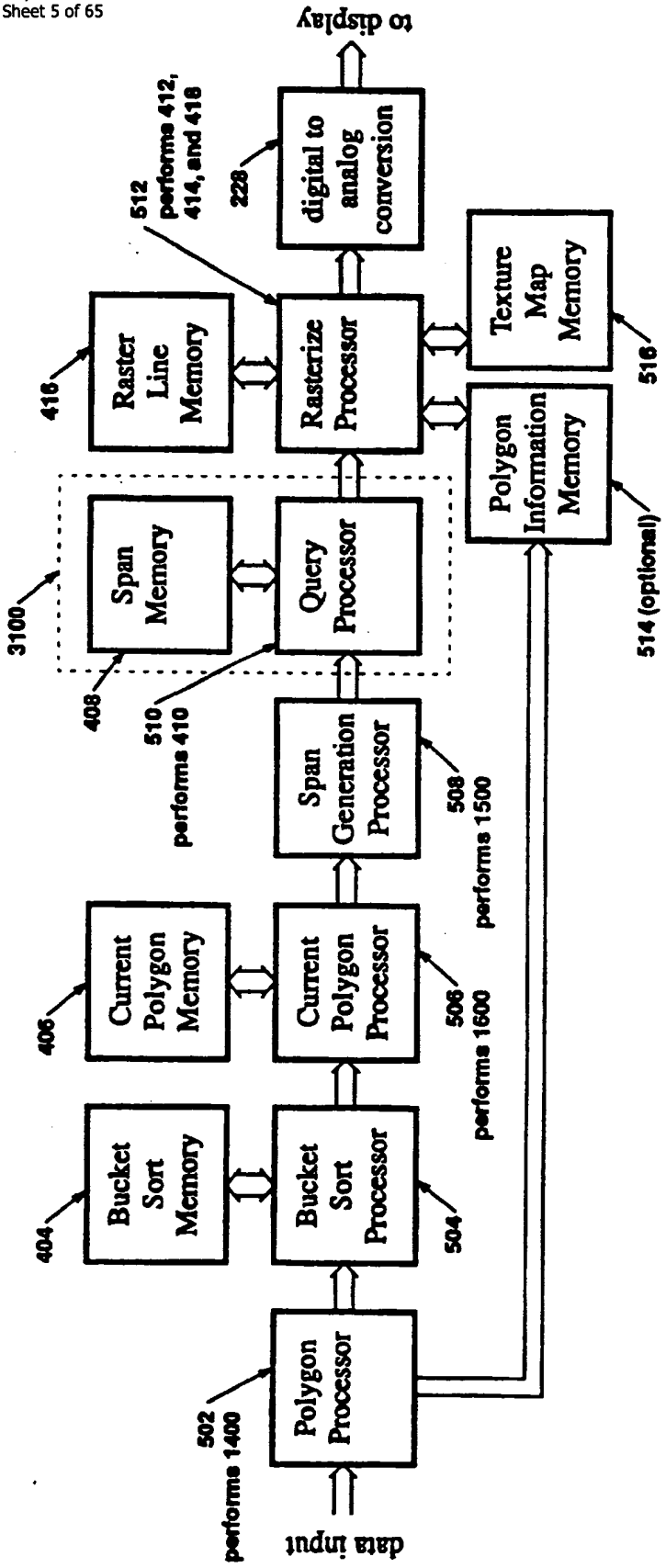


Figure 6 Generation and Sorting of Screen Coordinate Polygons and Spans

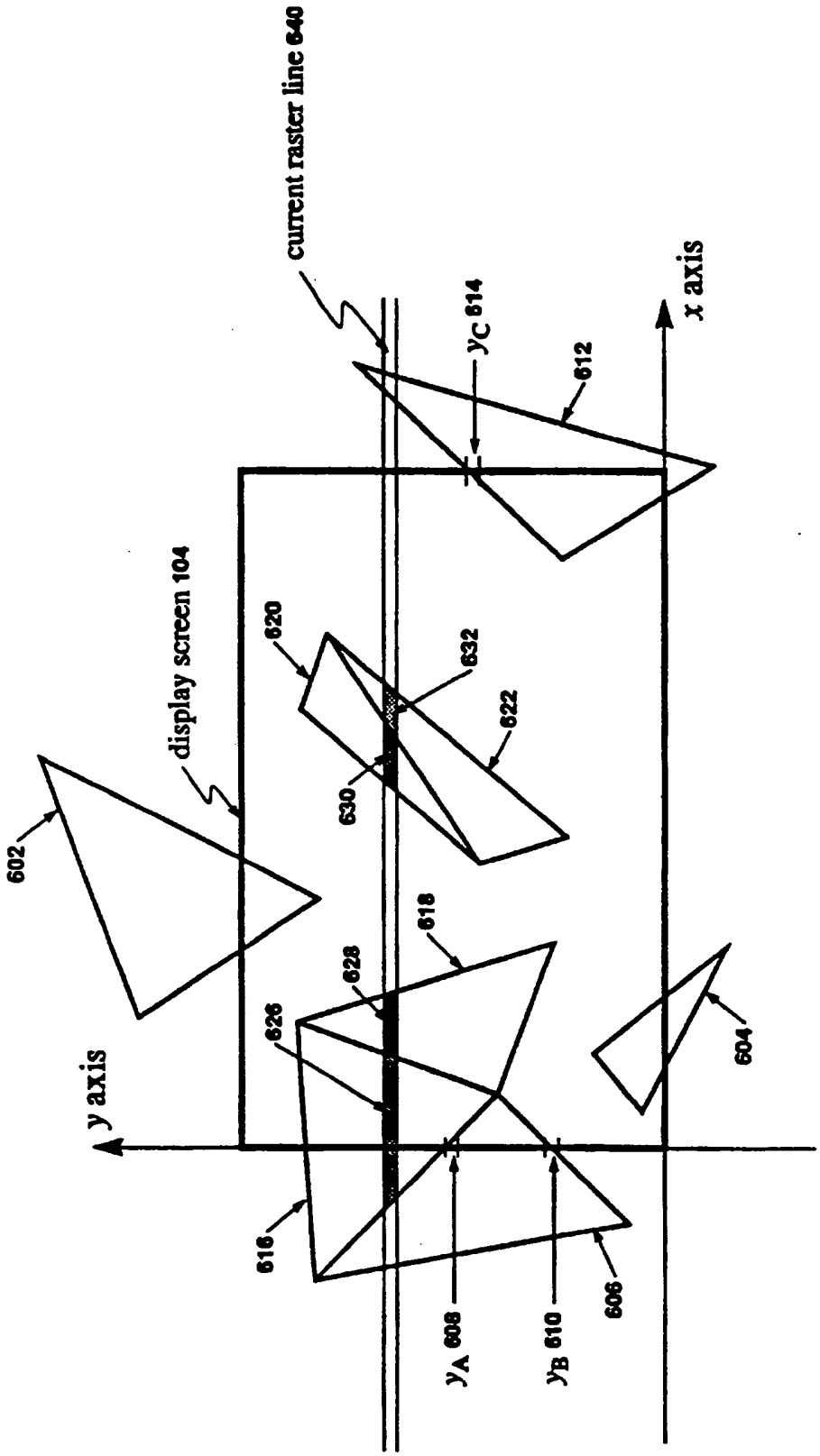


Figure 7 Three Ways to Model Spans

Figure 7A

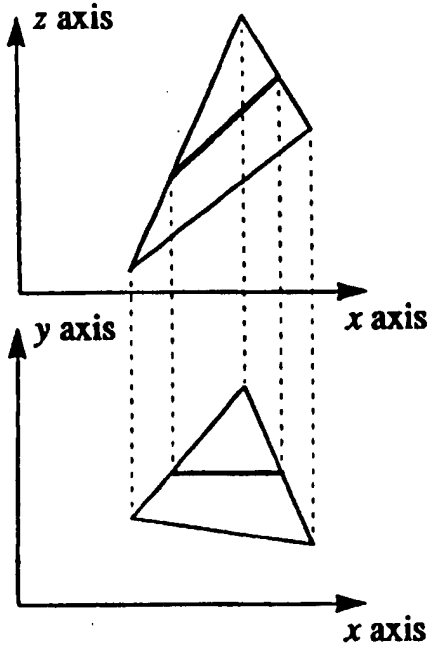


Figure 7B

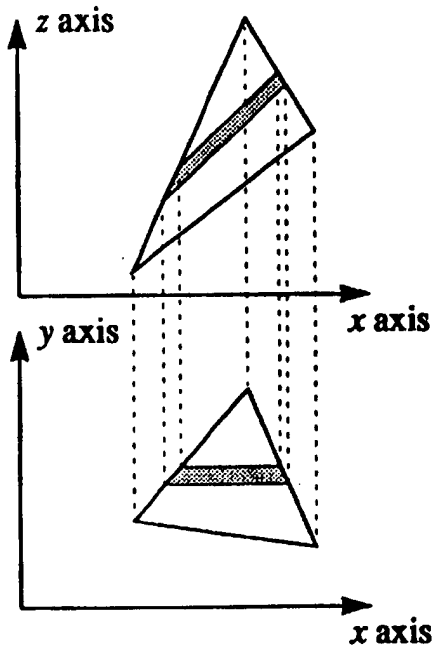


Figure 7C

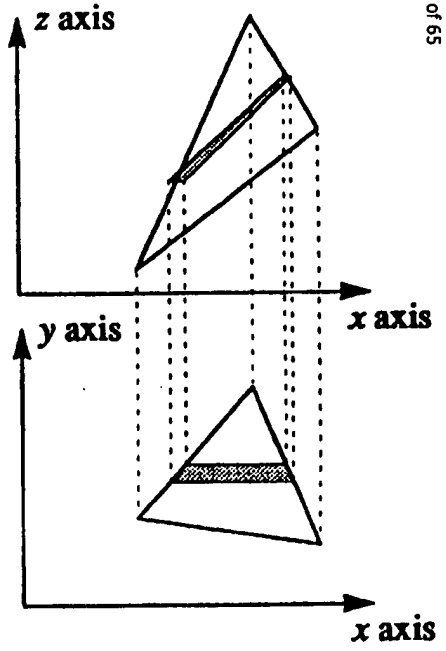


Figure 8 Data Storage within a Page of Span Memory

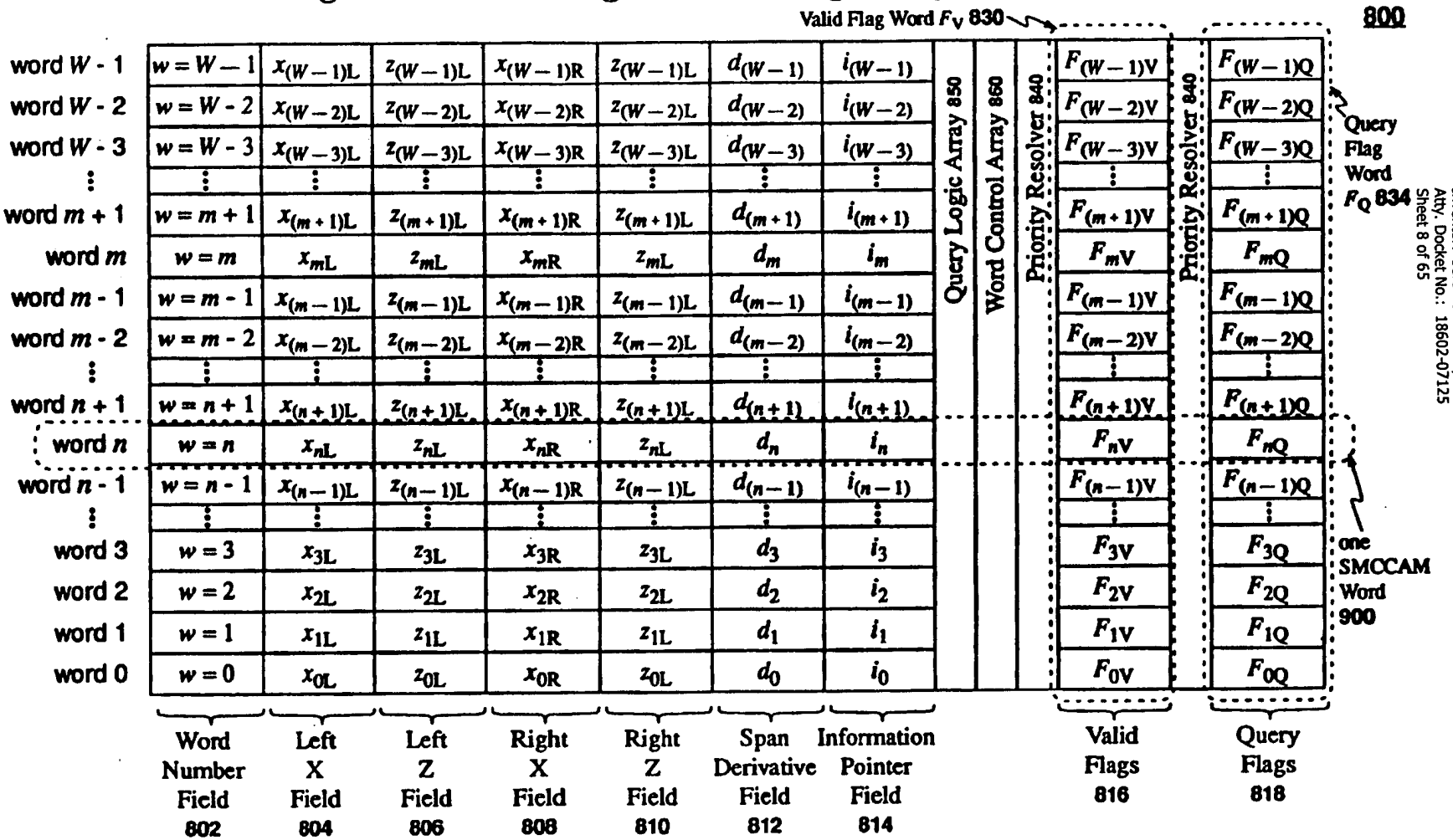


Figure 9 Block Diagram for SMCCAM Word

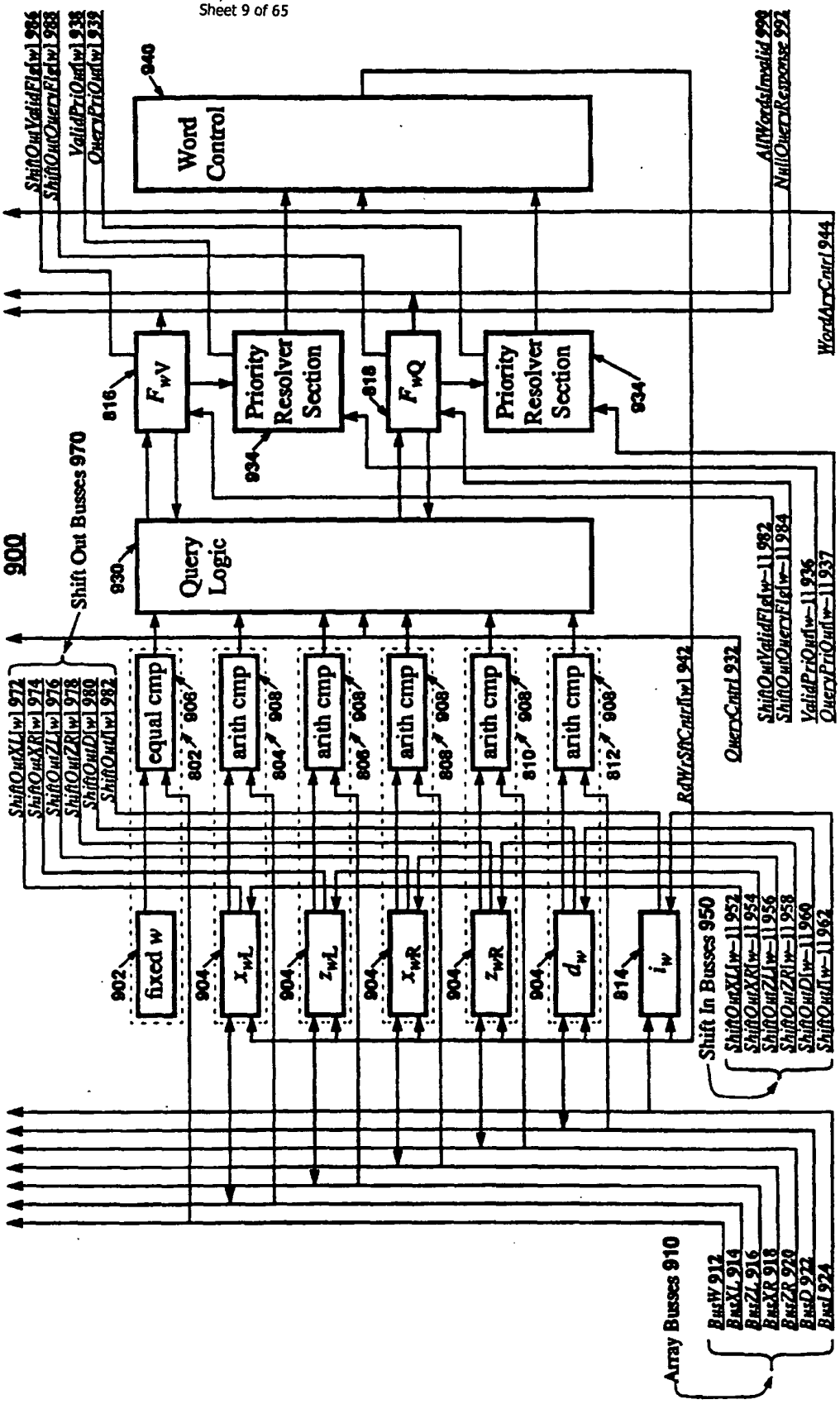


Figure 10 Span Occluding Test Query

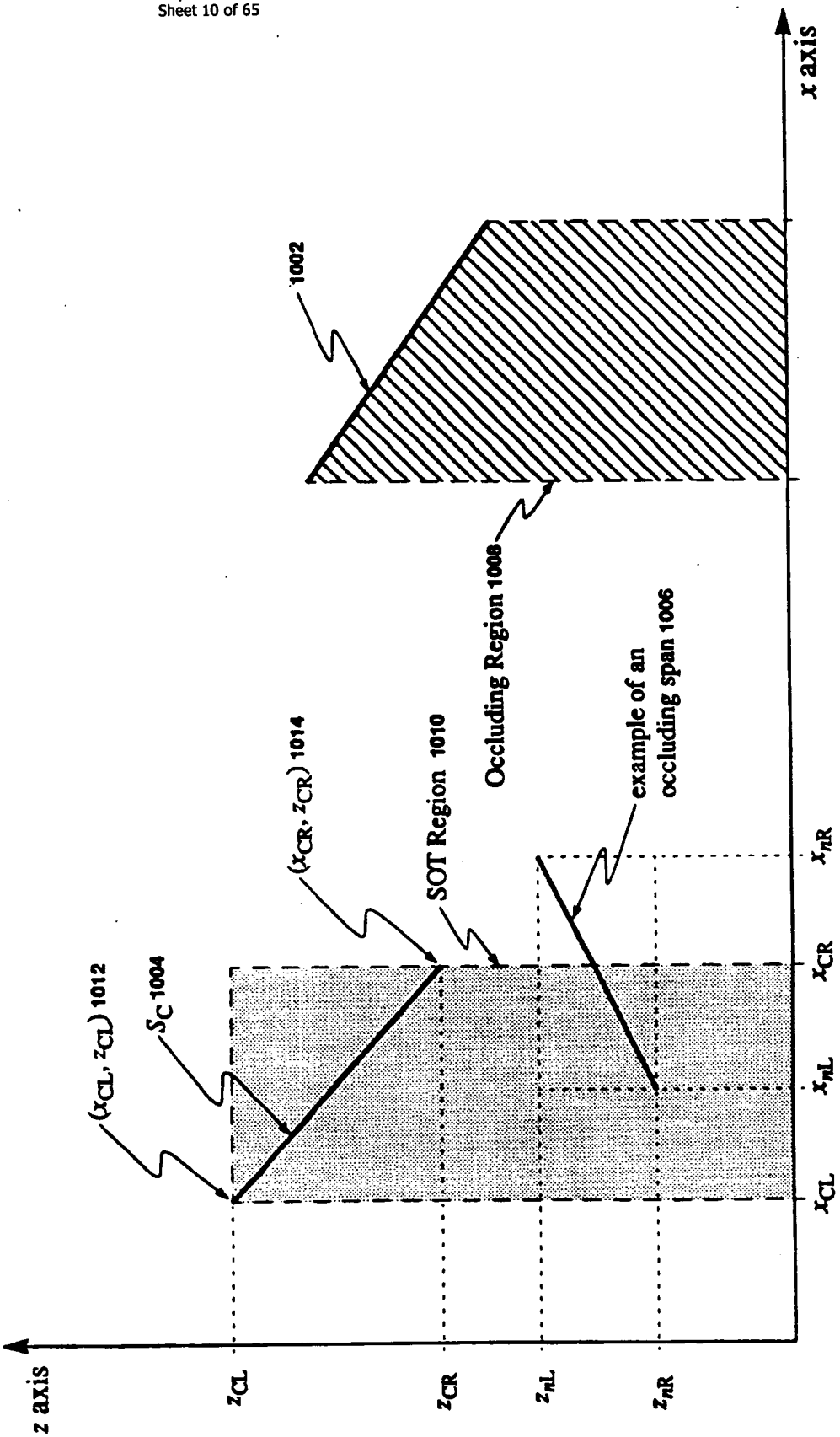


Figure 11 A Set of Spans on One Raster Line, Showing Visible Span Portions

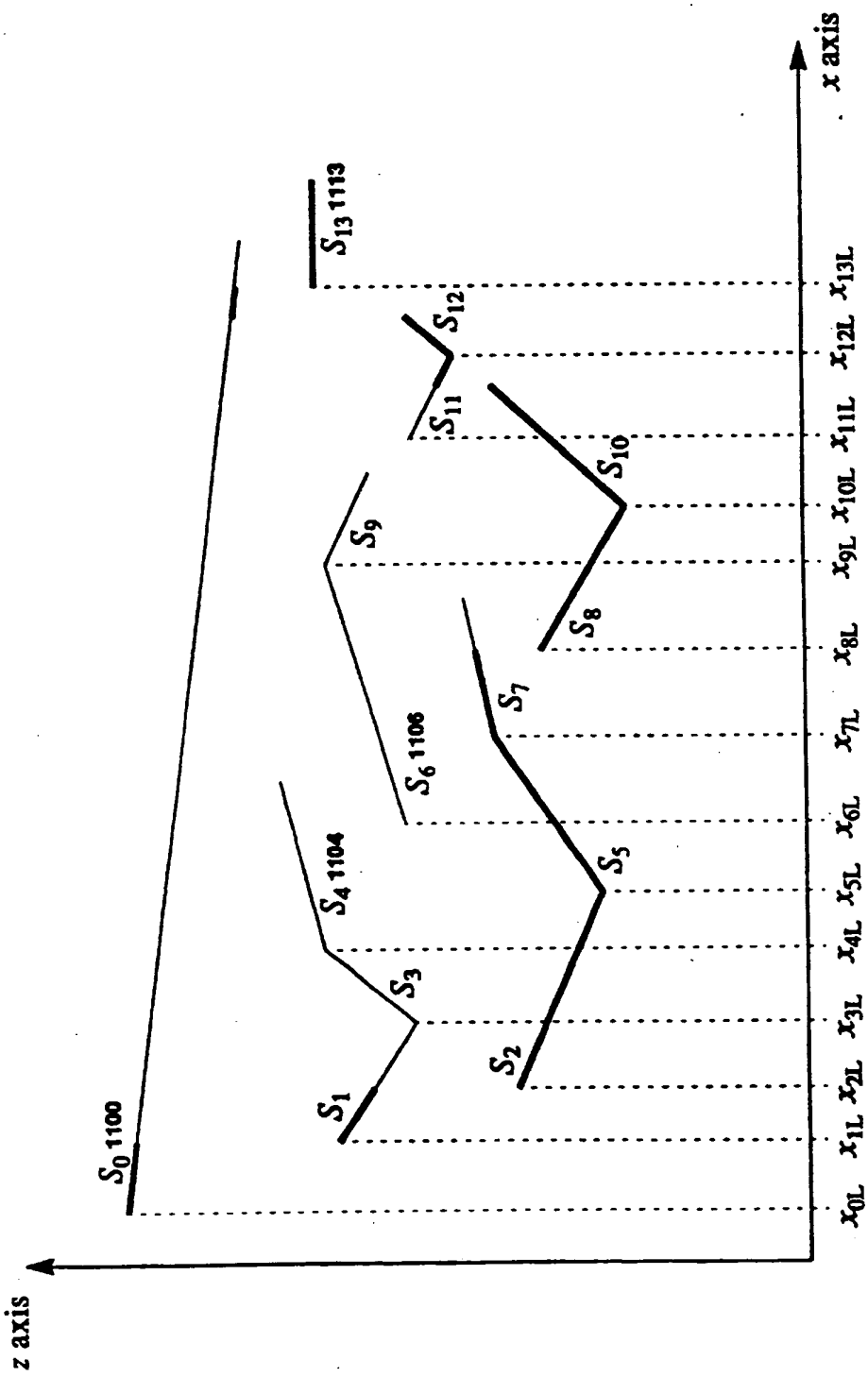


Figure 12 A Set of Spans on One Raster Line, Showing Span Bounding Boxes

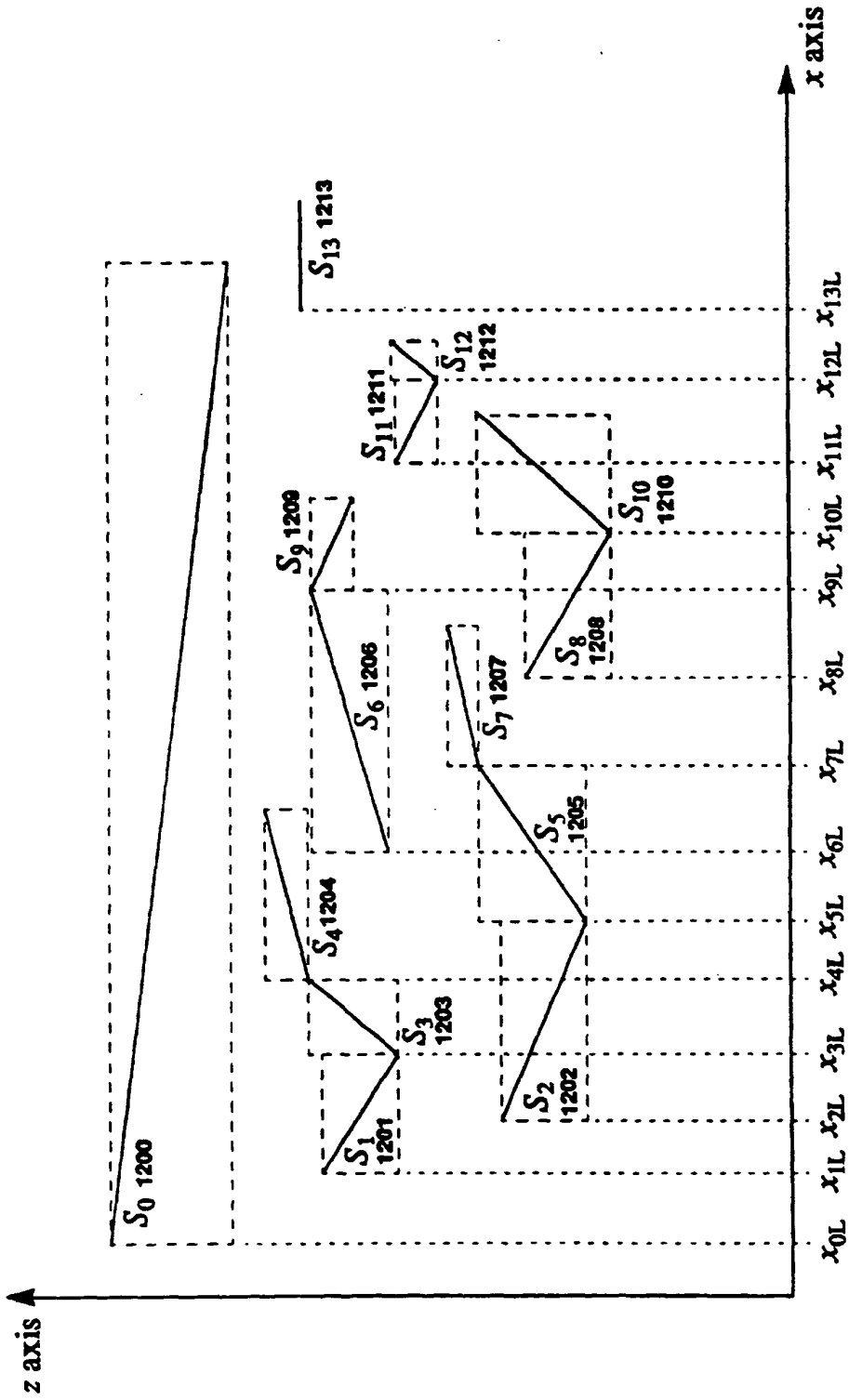


Figure 13 Span Sorting Rendering Method (SSRM)

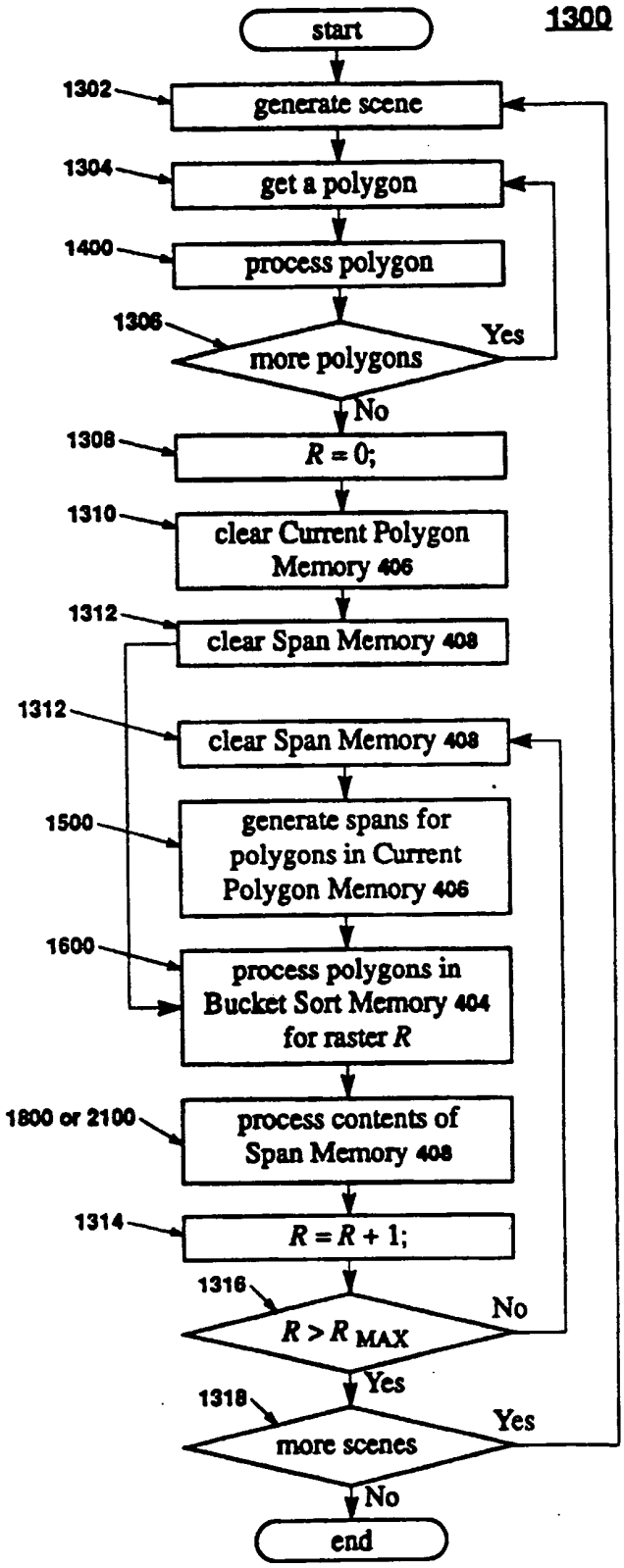


Figure 14 Process Polygon Method (in SSRM)

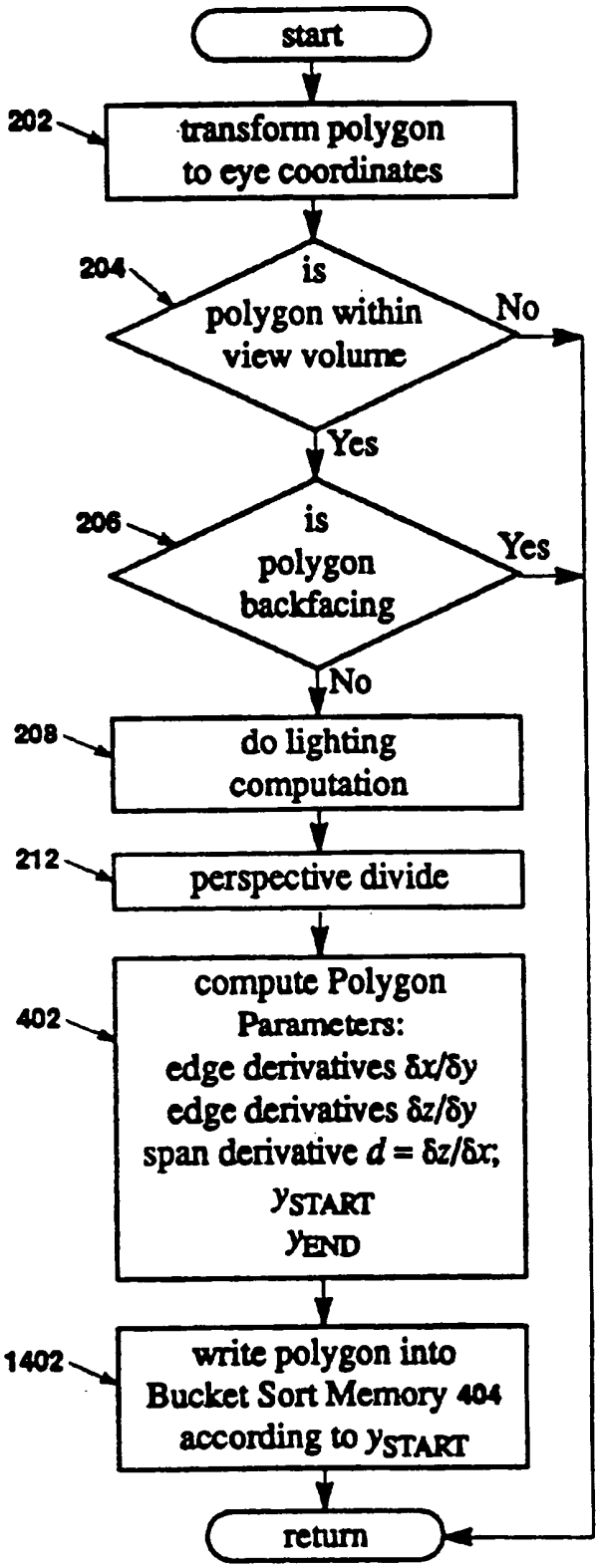


Figure 15 Process Current Polygon Memory (in SSRM)

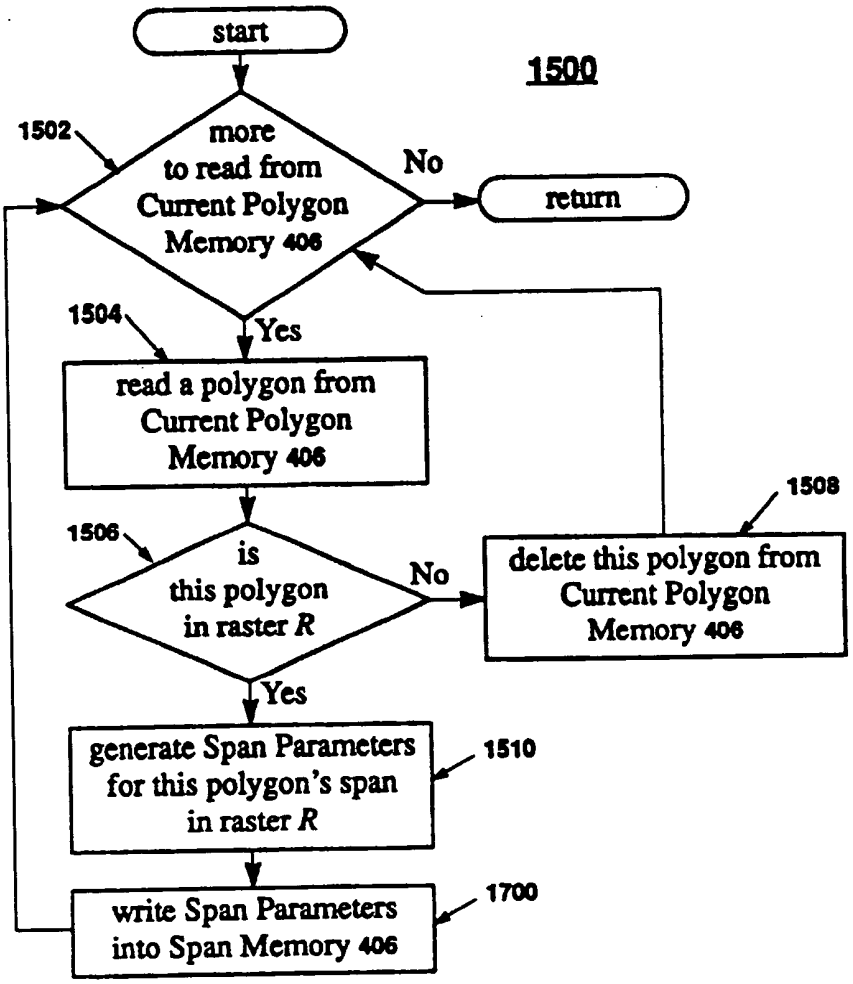


Figure 16 Process Bucket Sort Memory (in SSRM)

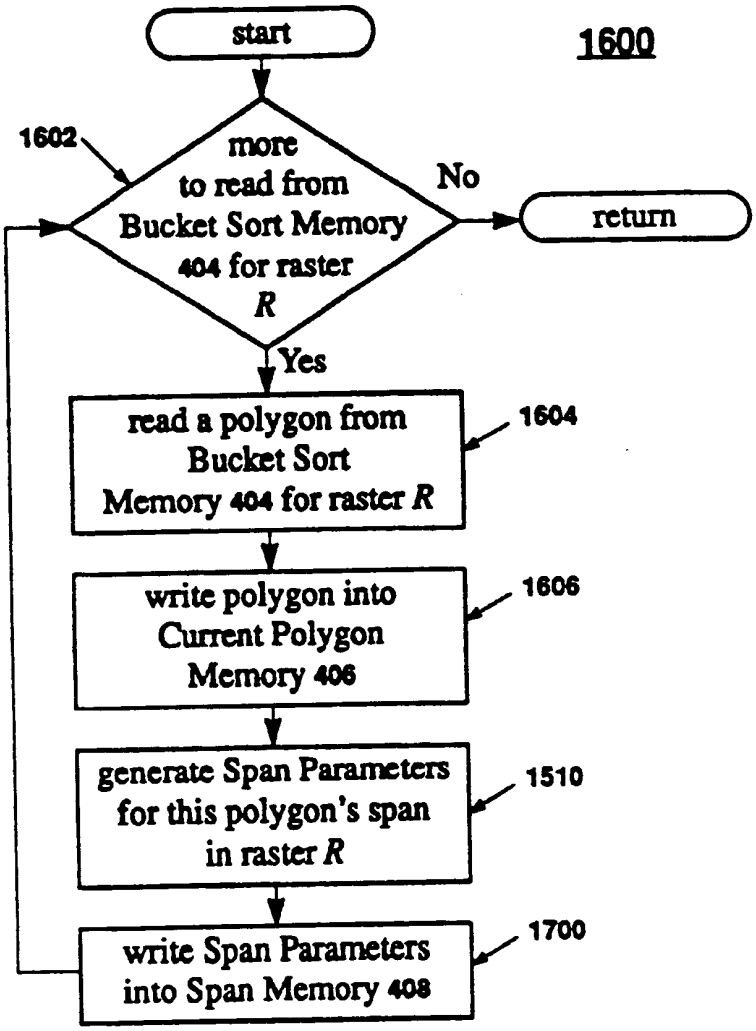


Figure 17 Write Span Parameters into SMCCAM

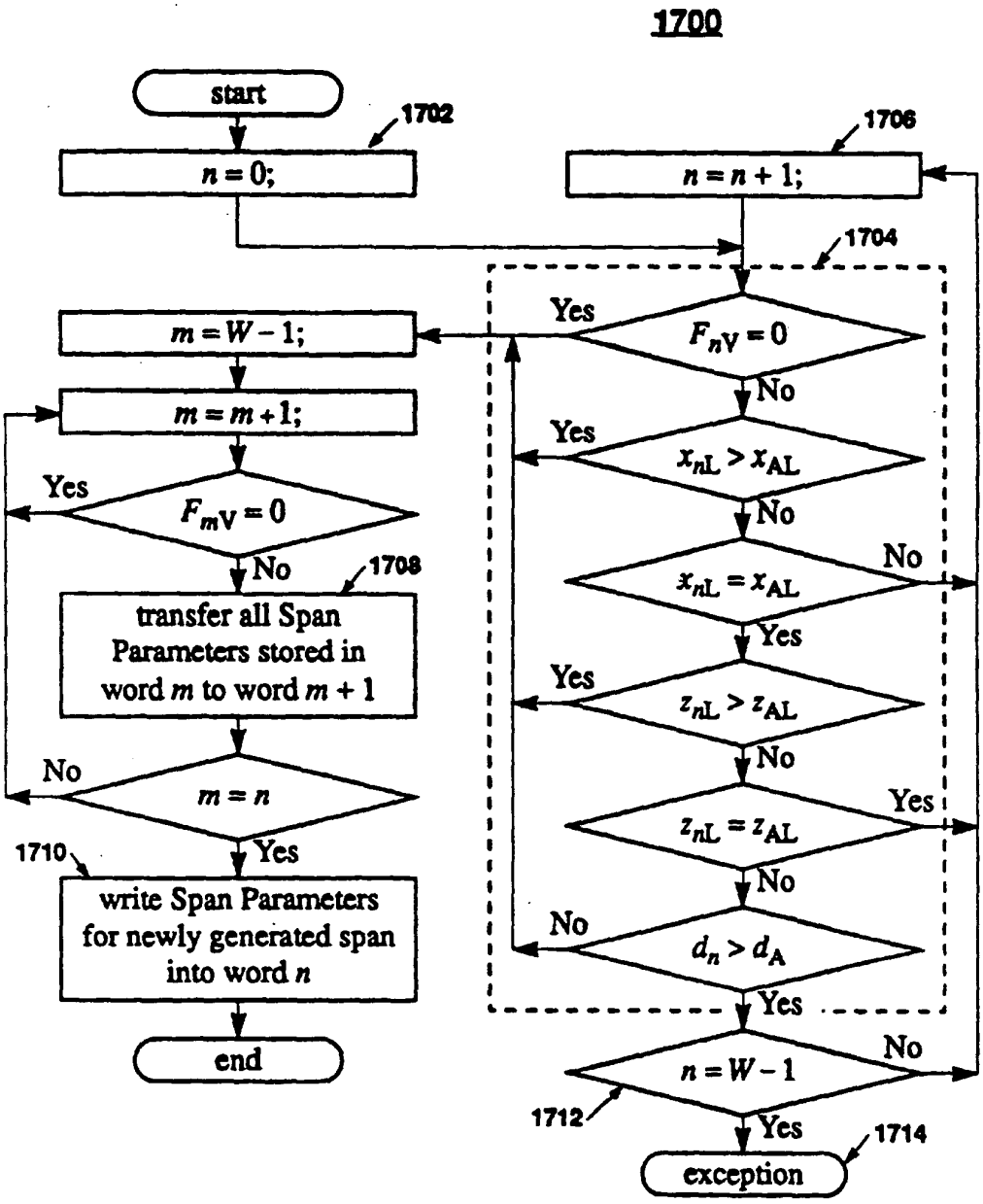
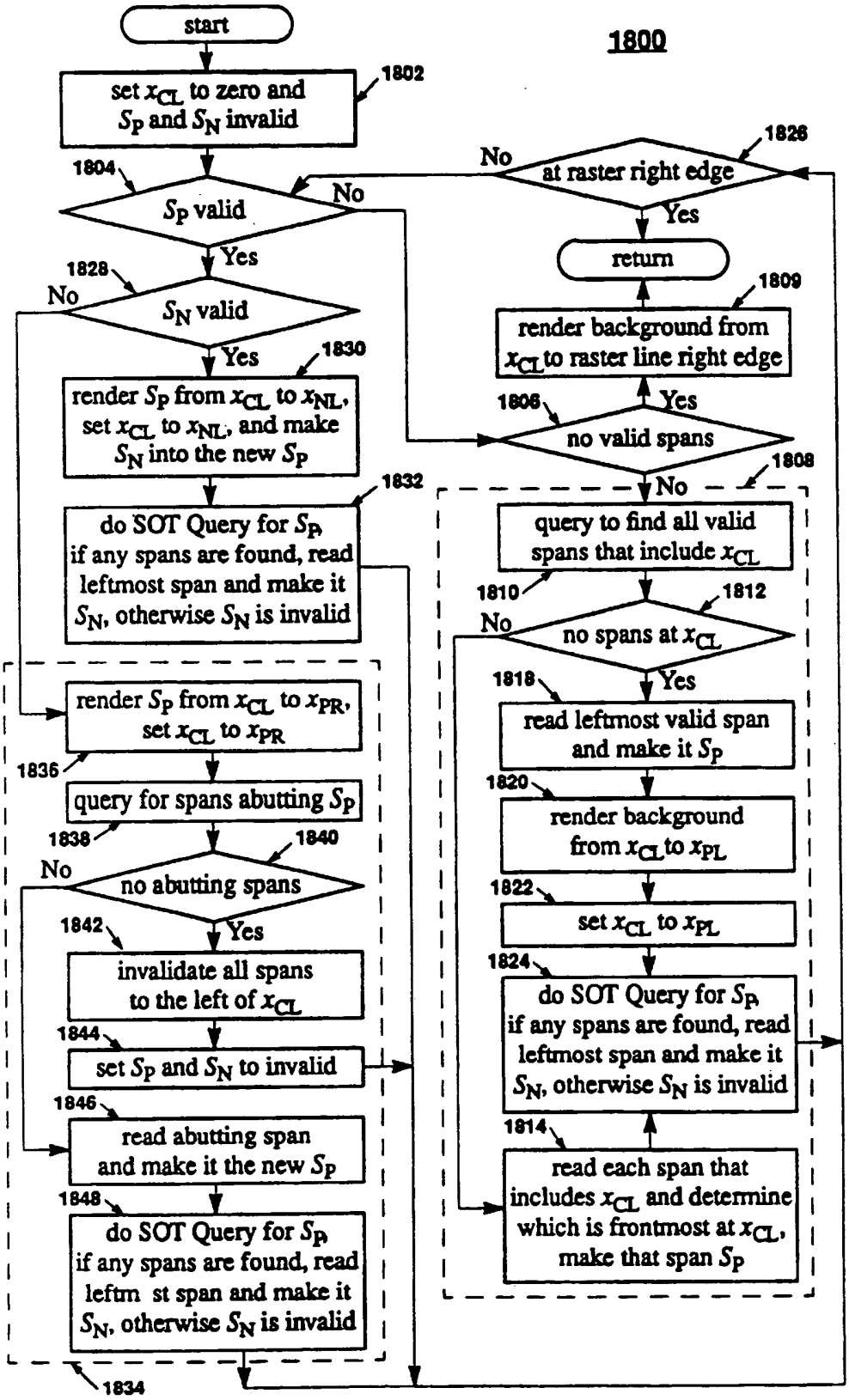


Figure 18 Simplified Span Rasterization Method



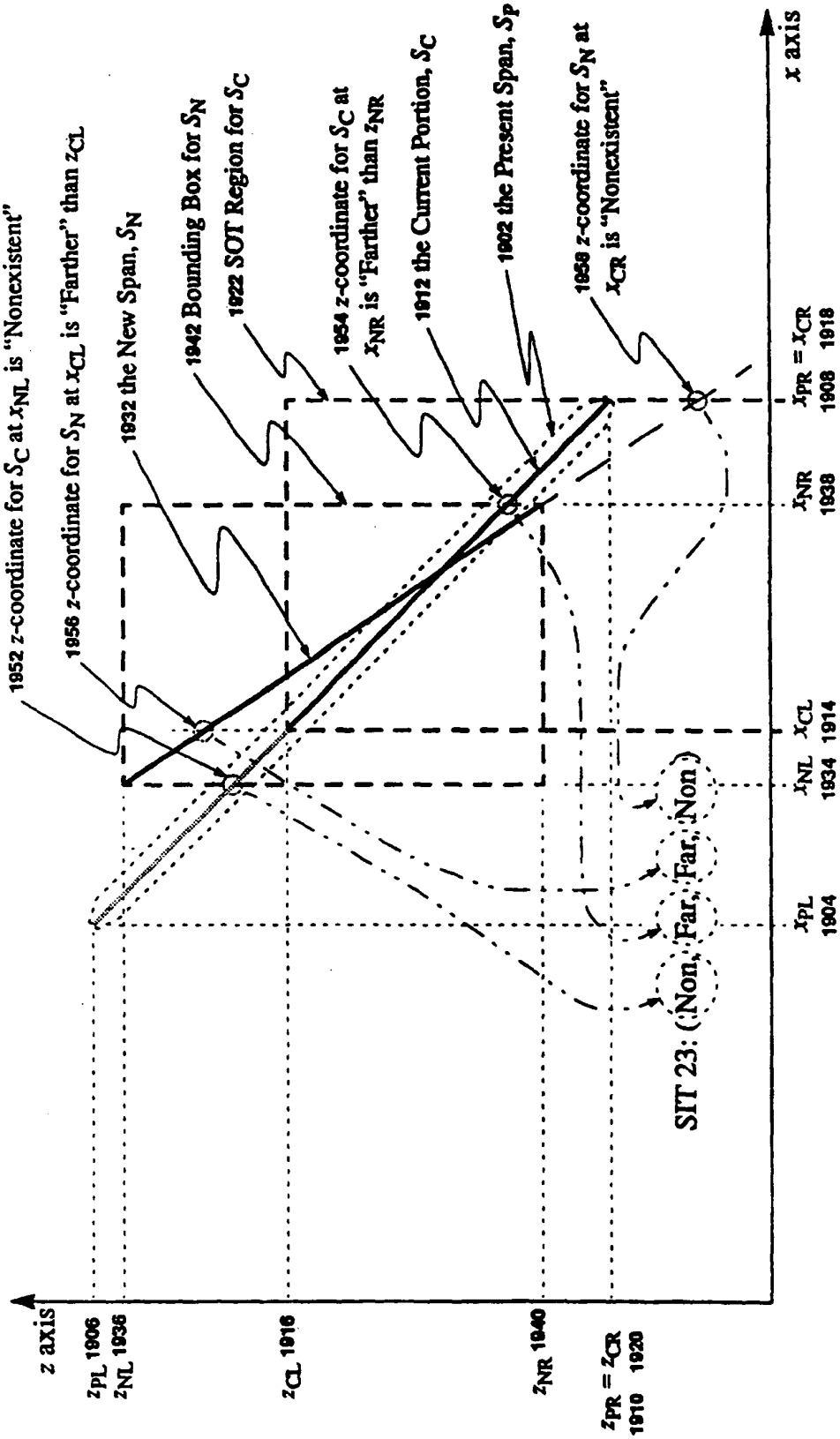


Figure 19 Span Interaction Nomenclature Definitions
1952 z-coordinate for S_C at x_{NL} is "Nonexistent"
1956 z-coordinate for S_N at x_{CL} is "Farther" than z_{CL}
1932 the New Span, S_N
1942 Bounding Box for S_N
1922 SOT Region for S_C
1954 z-coordinate for S_C at x_{NR} is "Farther" than z_{NR}
1912 the Current Portion, S_C
1902 the Present Span, S_P
1958 z-coordinate for S_N at x_{CR} is "Nonexistent"
x axis
z axis
z_{PL} 1906
z_{NL} 1936
z_{CL} 1916
z_{NR} 1940
$z_{PR} = z_{CR}$
1910 1920
x_{PL} 1904
x_{NL} 1934
x_{CL} 1914
x_{NR} 1938
$x_{PR} = x_{CR}$
1908 1918
SIT 23: (Non, Far, Far, Non)

Figure 20 Types of Span Interactions

Figure 20A: Interaction Type 1 = (Near, Near, Non, Non) ⇒ Rule 5

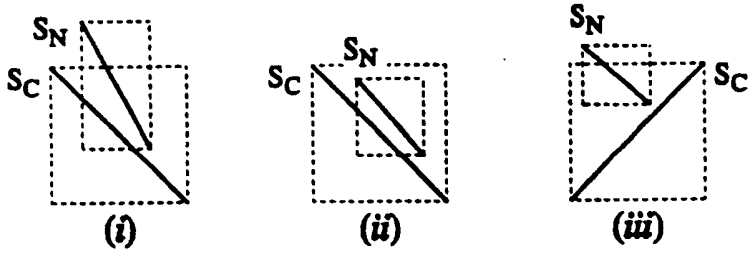


Figure 20B: Interaction Type 2 = (Near, Far, Non, Non) ⇒ Rule 4

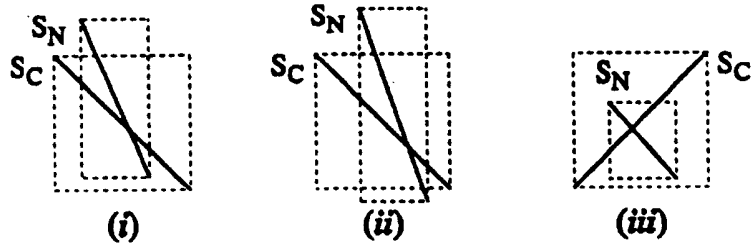


Figure 20C: Interaction Type 3 = (Near, Equal, Non, Non) ⇒ Rule 5

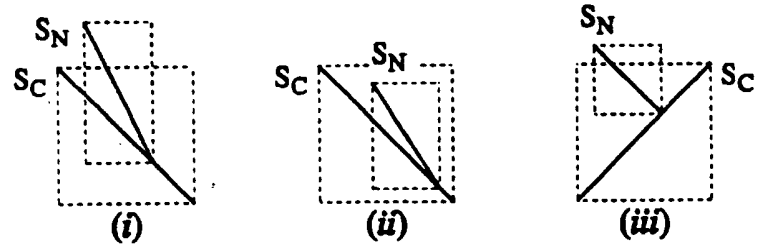


Figure 20D: Interaction Type 4 = (Far, Near, Non, Non) ⇒ Rule 3

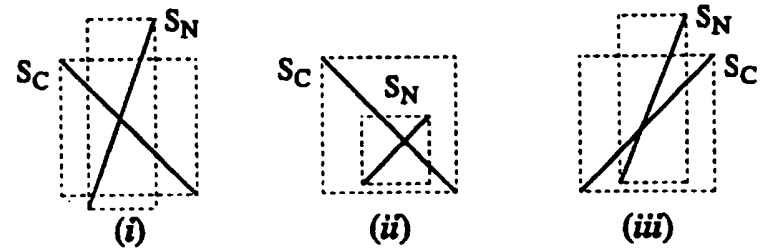


Figure 20E: Interaction Type 5 = (Far, Far, Non, Non) ⇒ Rule 3

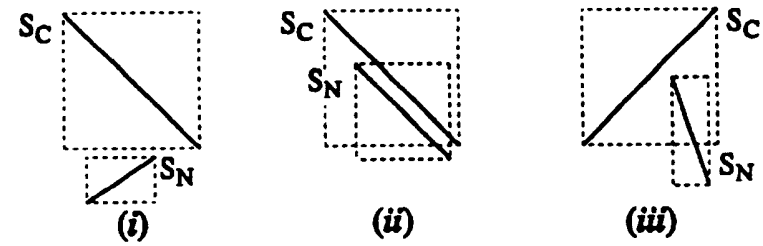


Figure 20 (continued) Types of Span Interactions

Figure 20F: Interaction Type 6:(Far, Equal, Non, Non) ⇒ Rule 3

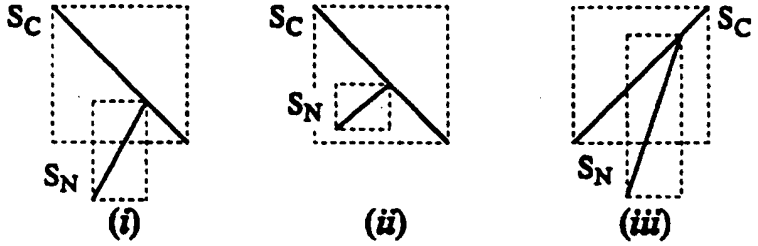


Figure 20G: Interaction Type 7 = (Equal, Near, Non, Non) ⇒ Rule 5

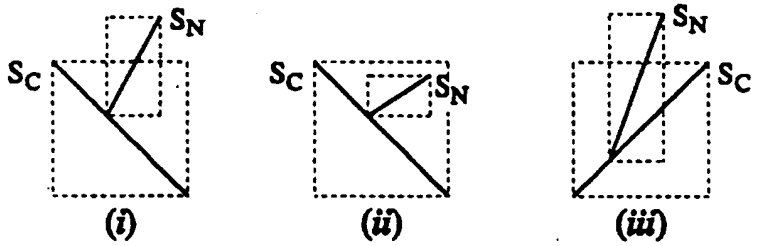


Figure 20H: Interaction Type 8 = (Equal, Far, Non, Non) ⇒ Rule 3

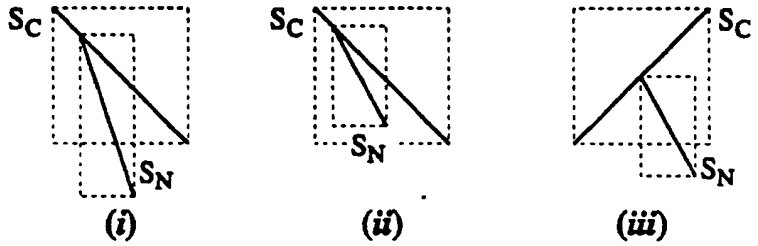


Figure 20I: Interaction Type 9 = (Equal, Equal, Non, Non) ⇒ Rule 5

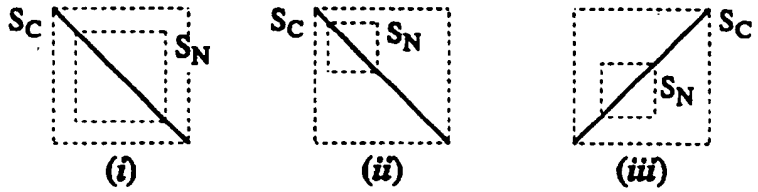


Figure 20J: Interaction Type 10 = (Near, Non, Non, Near) ⇒ Rule 4

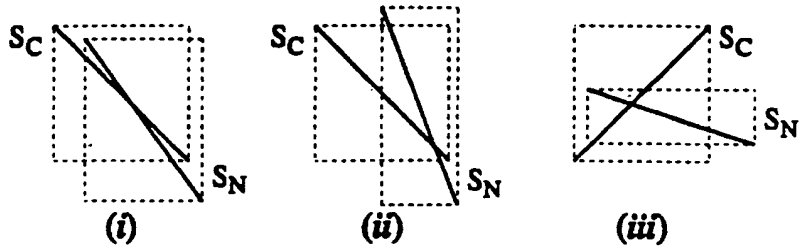


Figure 20 (continued) Types of Span Interactions

Figure 20K: Interaction Type 11 = (Near, Non, Non, Far) ⇒ Rule 5

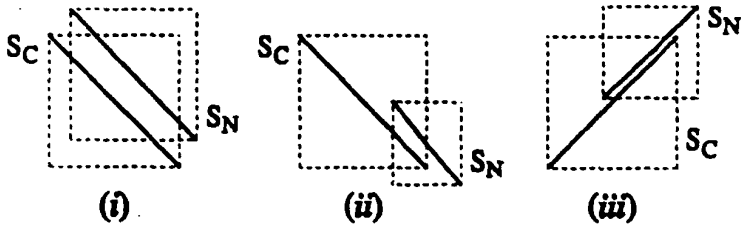


Figure 20L: Interaction Type 12 = (Near, Non, Non, Equal) ⇒ Rule 5

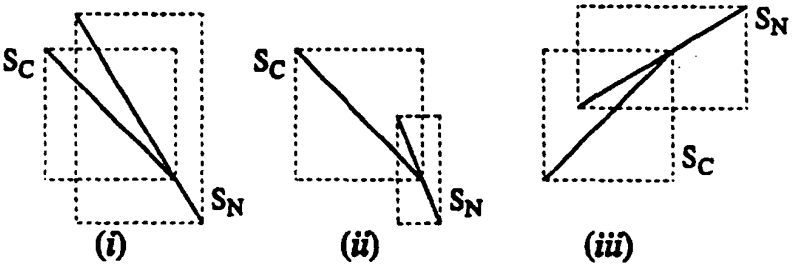


Figure 20M: Interaction Type 13 = (Far, Non, Non, Near) ⇒ Rule 3

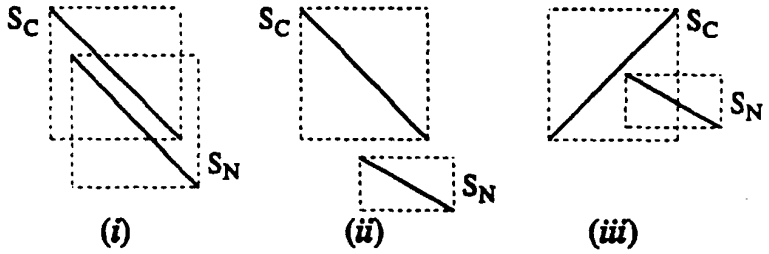


Figure 20N: Interaction Type 14 = (Far, Non, Non, Far) ⇒ Rule 3

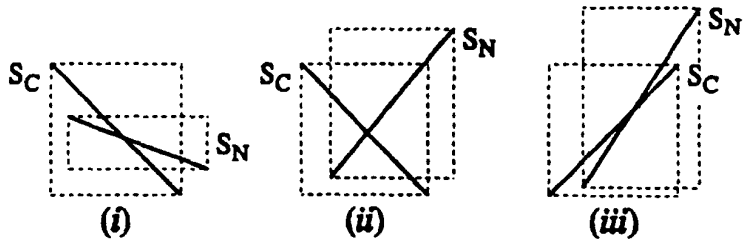


Figure 20O: Interaction Type 15 = (Far, Non, Non, Equal) ⇒ Rule 3

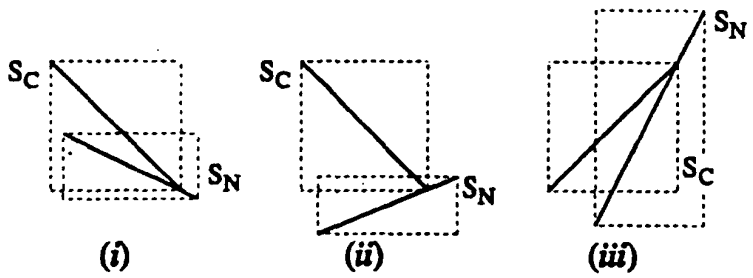


Figure 20 (continued) Types of Span Interactions

Figure 20P: Interaction Type 16 = (Equal, Non, Non, Near) ⇒ Rule 3

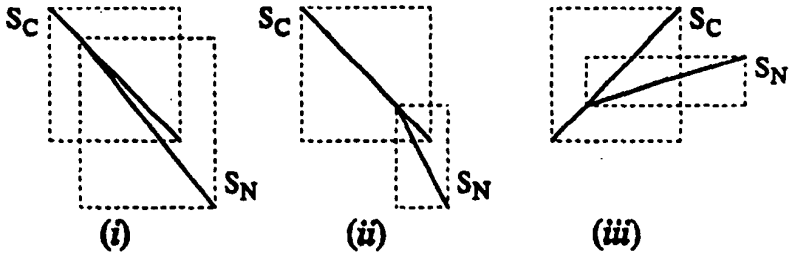


Figure 20Q: Interaction Type 17 = (Equal, Non, Non, Far) ⇒ Rule 5

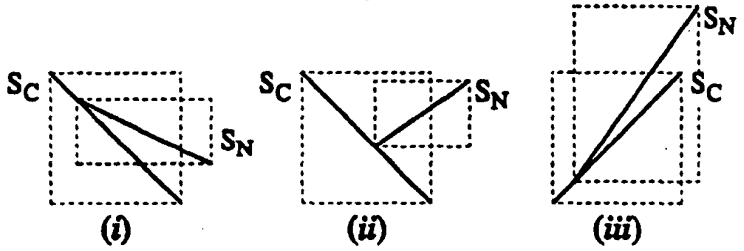


Figure 20R: Interaction Type 18 = (Equal, Non, Non, Equal) ⇒ Rule 5

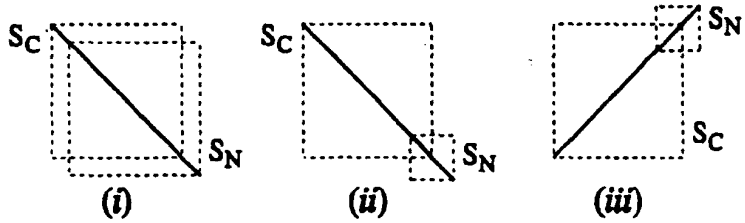


Figure 20S: Interaction Type 19 = (Non, Near, Near, Non) ⇒ impossible

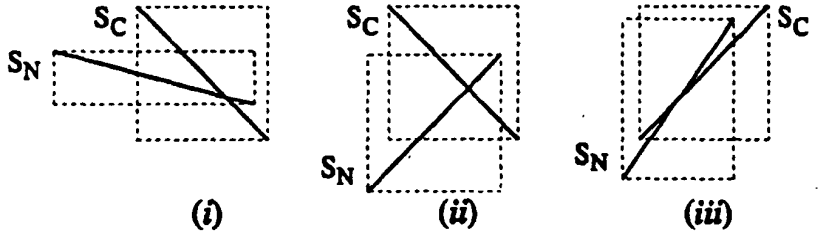


Figure 20T: Interaction Type 20 = (Non, Near, Far, Non) ⇒ Rule 5

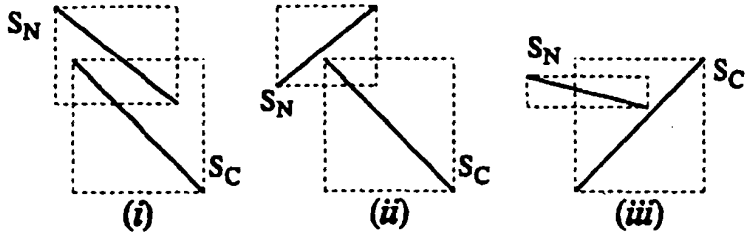


Figure 20 (continued) Types of Span Interactions

Figure 20U: Interaction Type 21 = (N n, Near, Equal, Non) ⇒ Rule 5

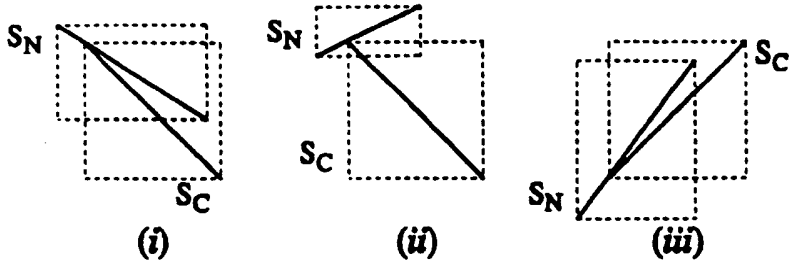


Figure 20V: Interaction Type 22 = (Non, Far, Near, Non) ⇒ impossible

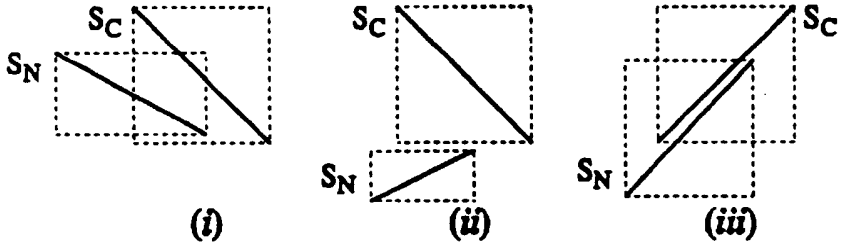


Figure 20W: Interaction Type 23 = (Non, Far, Far, Non) ⇒ Rule 4

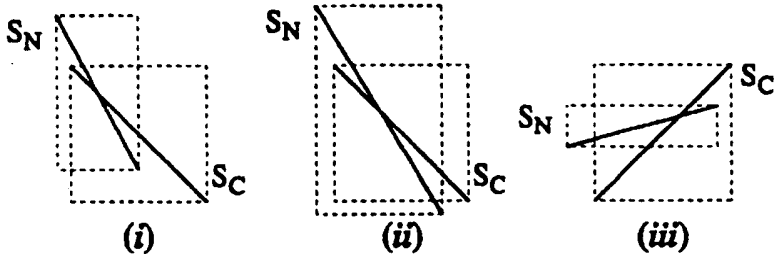


Figure 20X: Interaction Type 24 = (Non, Far, Equal, Non) ⇒ impossible

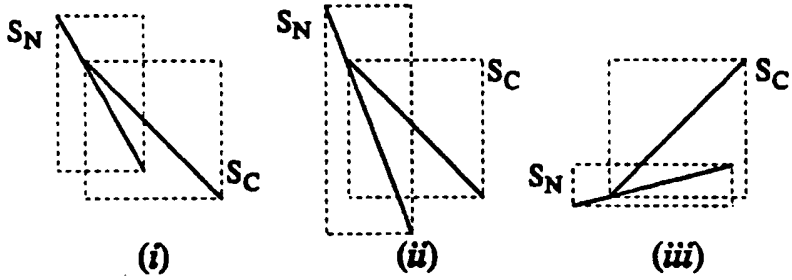


Figure 20Y: Interaction Type 25 = (Non, Equal, Near, Non) ⇒ impossible

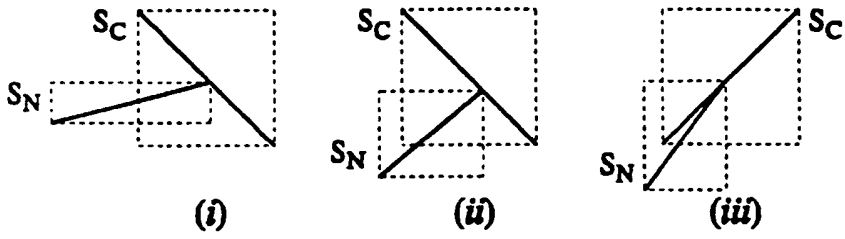


Figure 20 (continued) Types of Span Interactions

Figure 20Z: Interaction Type 26 = (Non, Equal, Far, Non) ⇒ Rule 5

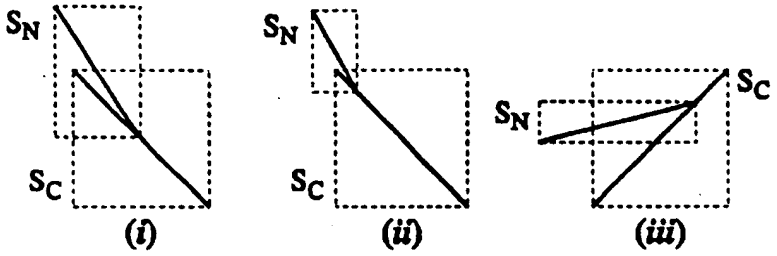


Figure 20AA: Interaction Type 27 = (Non, Equal, Equal, Non) ⇒ Rule 5

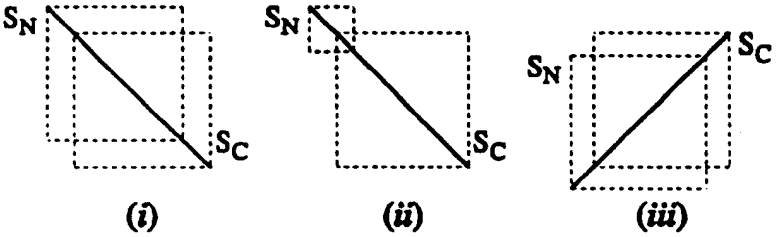


Figure 20BB: Interaction Type 28 = (Non, Non, Near, Near) ⇒ impossible

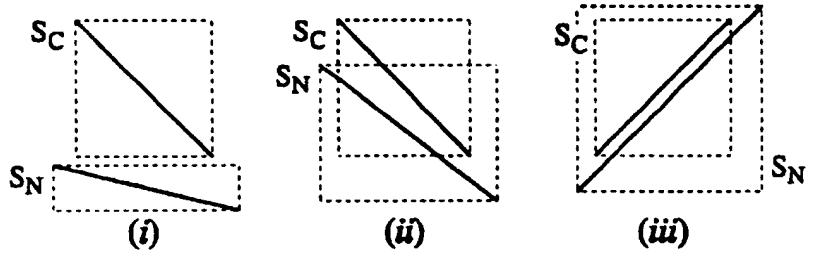


Figure 20CC: Interaction Type 29 = (Non, Non, Near, Far) ⇒ impossible

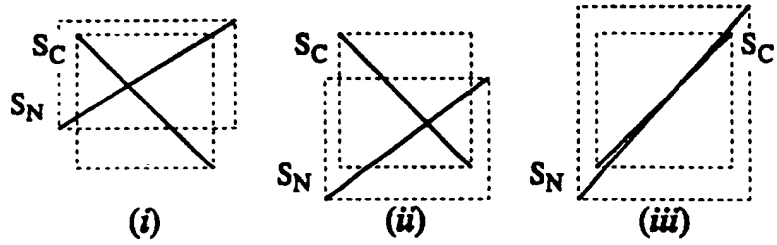


Figure 20DD: Interaction Type 30 = (Non, Non, Near, Equal) ⇒ impossible

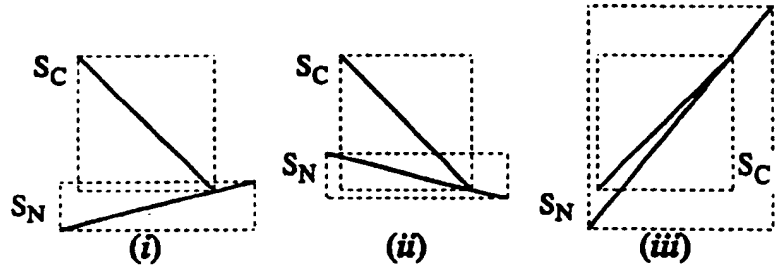


Figure 20 (continued) Types of Span Interactions

Figure 20EE: Interaction Type 31 = (Non, Non, Far, Near) ⇒ Rule 4

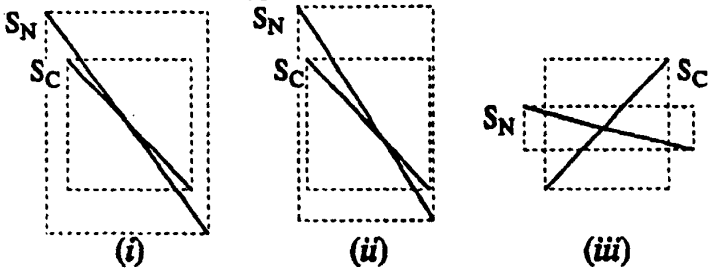


Figure 20FF: Interaction Type 32 = (Non, Non, Far, Far) ⇒ Rule 5

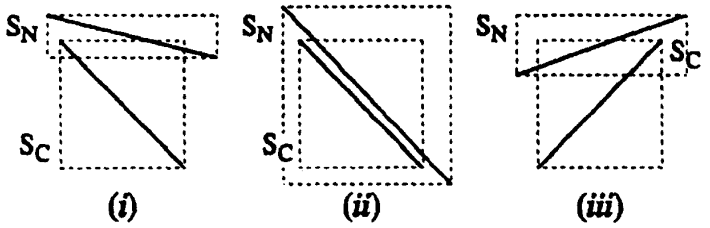


Figure 20GG: Interaction Type 33 = (Non, Non, Far, Equal) ⇒ Rule 5

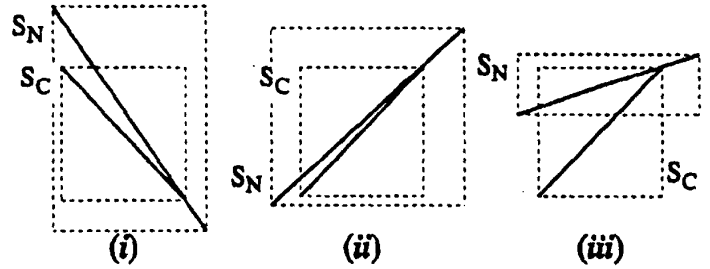


Figure 20HH: Interaction Type 34 = (Non, Non, Equal, Near) ⇒ impossible

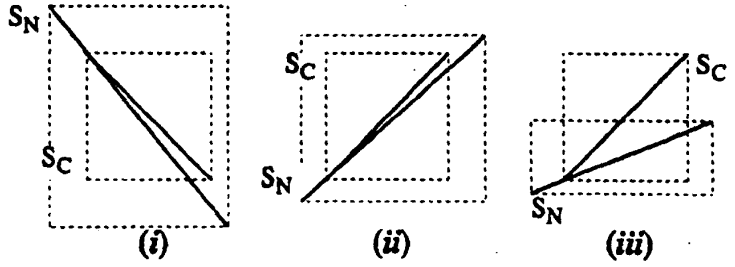


Figure 20II: Interaction Type 35 = (Non, Non, Equal, Far) ⇒ Rule 5

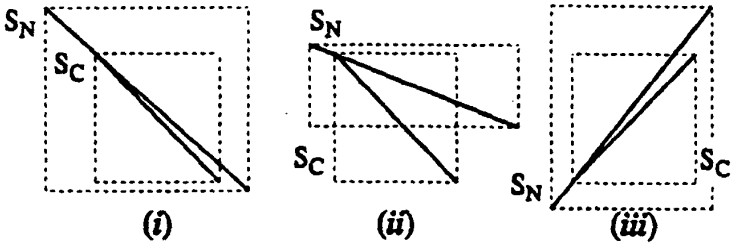


Figure 20 (c ntinued) Types of Span Interactions

Figure 20JJ: Interaction Type 36 = (Non, Non, Equal, Equal) ⇒ Rule 5

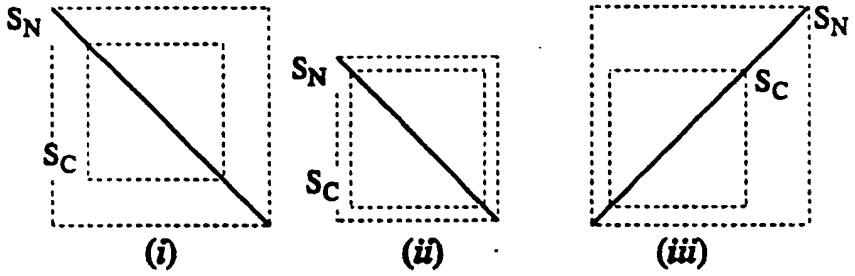


Figure 20KK: Interaction Type 37 = (Equal, Near, Equal, Non) ⇒ Rule 5

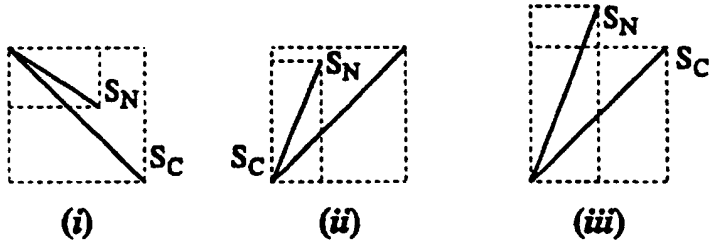


Figure 20LL: Interaction Type 38 = (Equal, Far, Equal, Non) ⇒ impossible

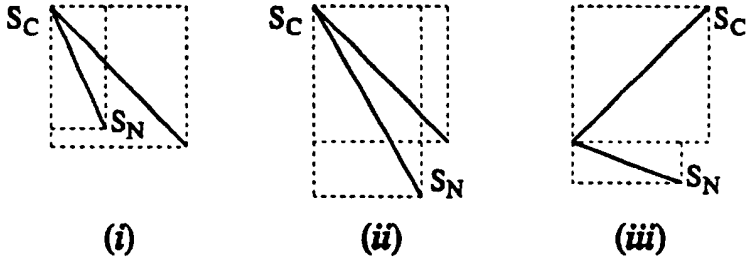


Figure 20MM: Interaction Type 39 = (Equal, Equal, Equal, Non) ⇒ Rule 5

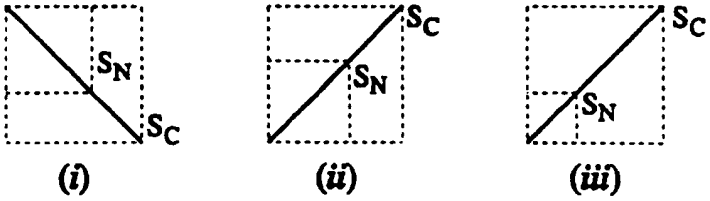


Figure 20NN: Interaction Type 40 = (Equal, Non, Equal, Near) ⇒ impossible

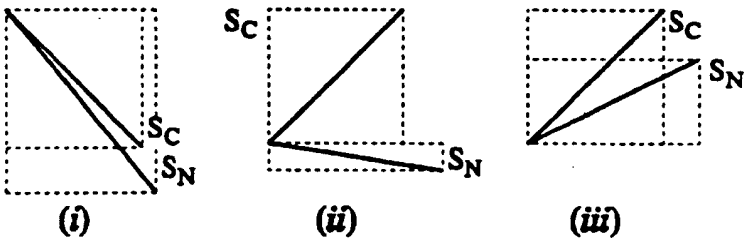


Figure 20 (continued) Types of Span Interactions

Figure 20OO : Interaction Type 41 = (Equal, Non, Equal, Far) ⇒ Rule 5

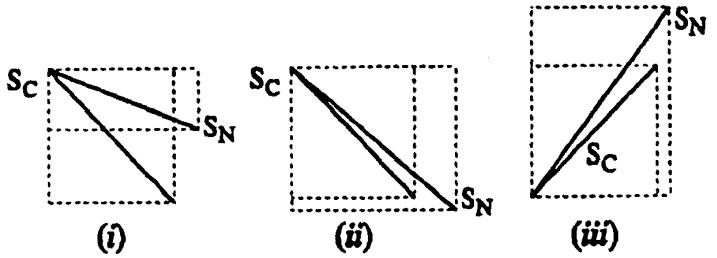


Figure 20PP: Interaction Type 42 = (Equal, Non, Equal, Equal) ⇒ Rule 5

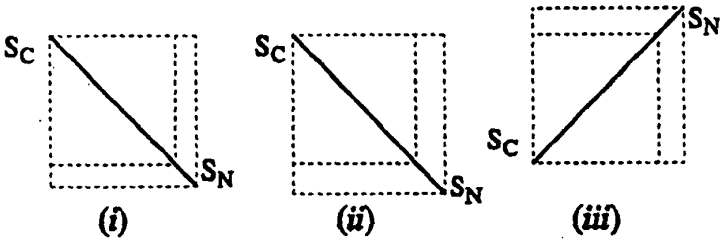


Figure 20QQ: Interaction Type 43 = (Near, Equal, Non, Equal) ⇒ Rule 5

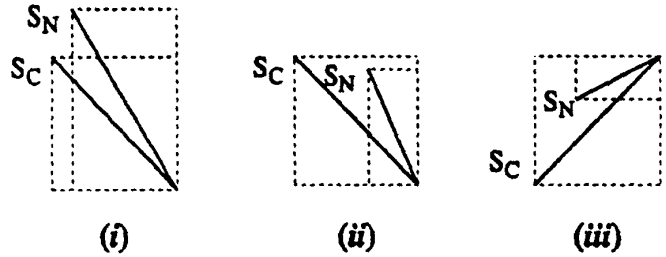


Figure 20RR: Interaction Type 44 = (Far, Equal, Non, Equal) ⇒ Rule 3

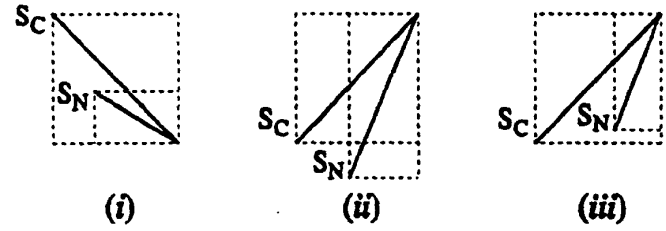


Figure 20SS: Interaction Type 45 = (Equal, Equal, Non, Equal) ⇒ Rule 5

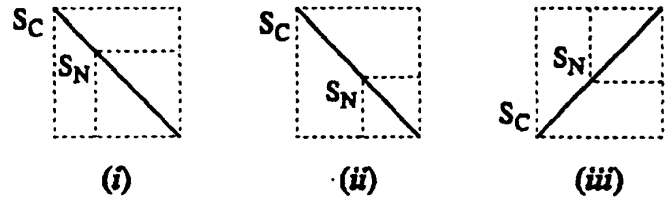


Figure 20 (continued) Types of Span Interactions

Figure 20TT: Interaction Type 46 = (Non, Equal, Near, Equal) ⇒ impossible

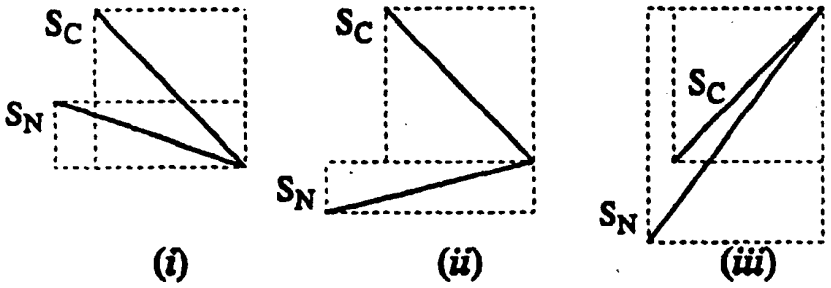


Figure 20UU: Interaction Type 47 = (Non, Equal, Far, Equal) ⇒ Rule 5

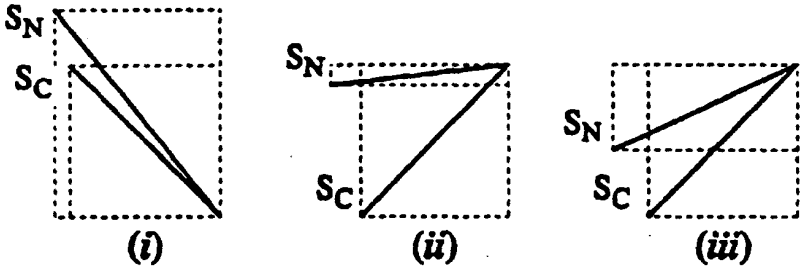


Figure 20VV: Interaction Type 48 = (Non, Equal, Equal, Equal) ⇒ Rule 5

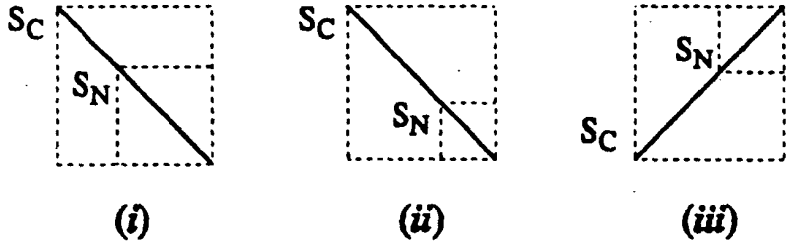


Figure 20WW: Interaction Type 49 = (Equal, Equal, Equal, Equal) ⇒ Rule 5

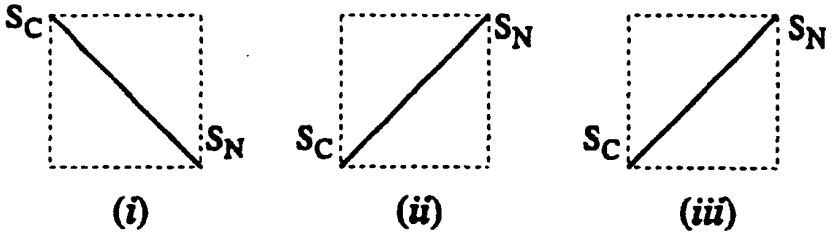


Figure 21 Segment Span Rasterization Method (SSRM)

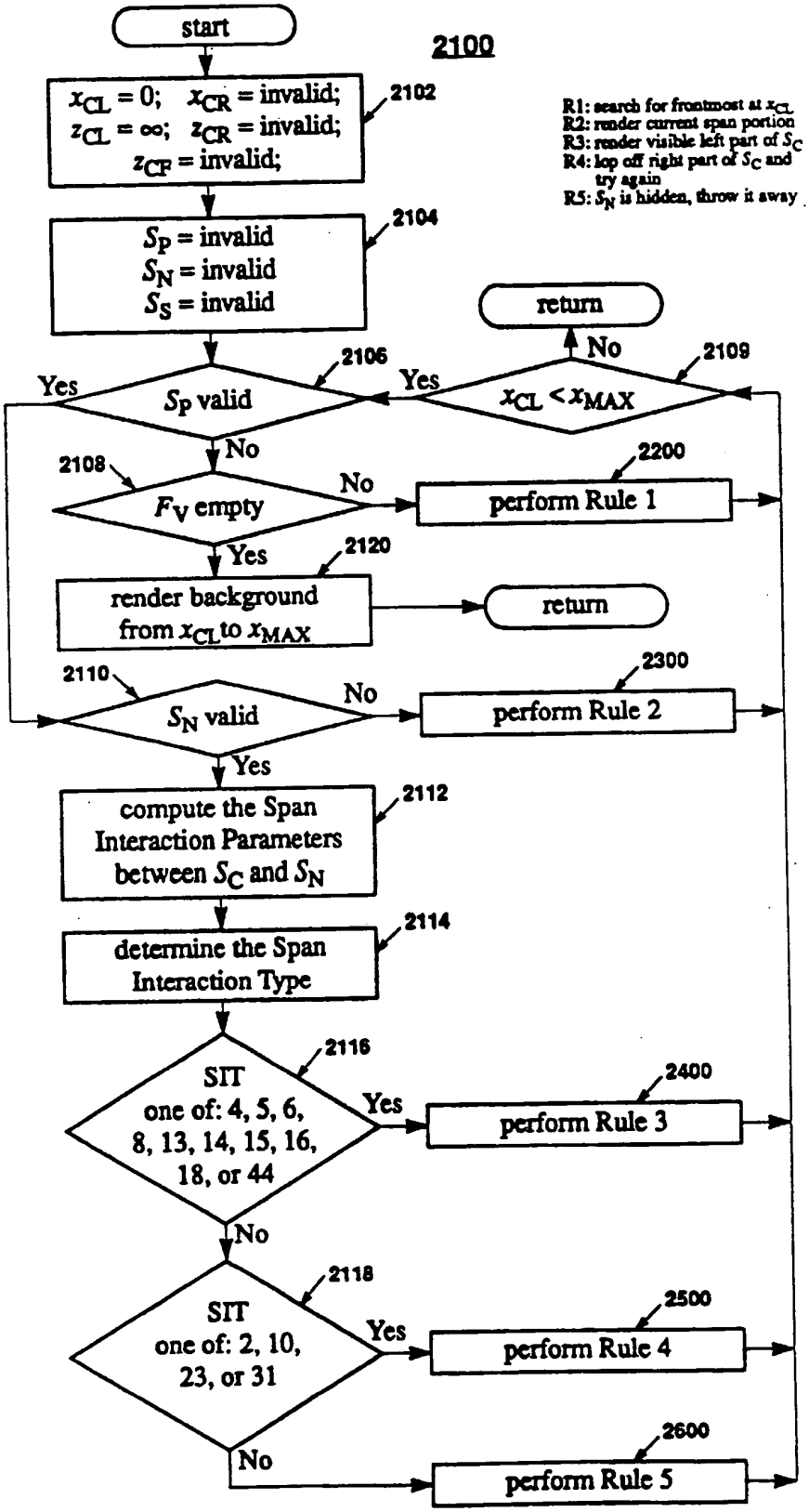


Figure 22 Rule 1 of SSRM

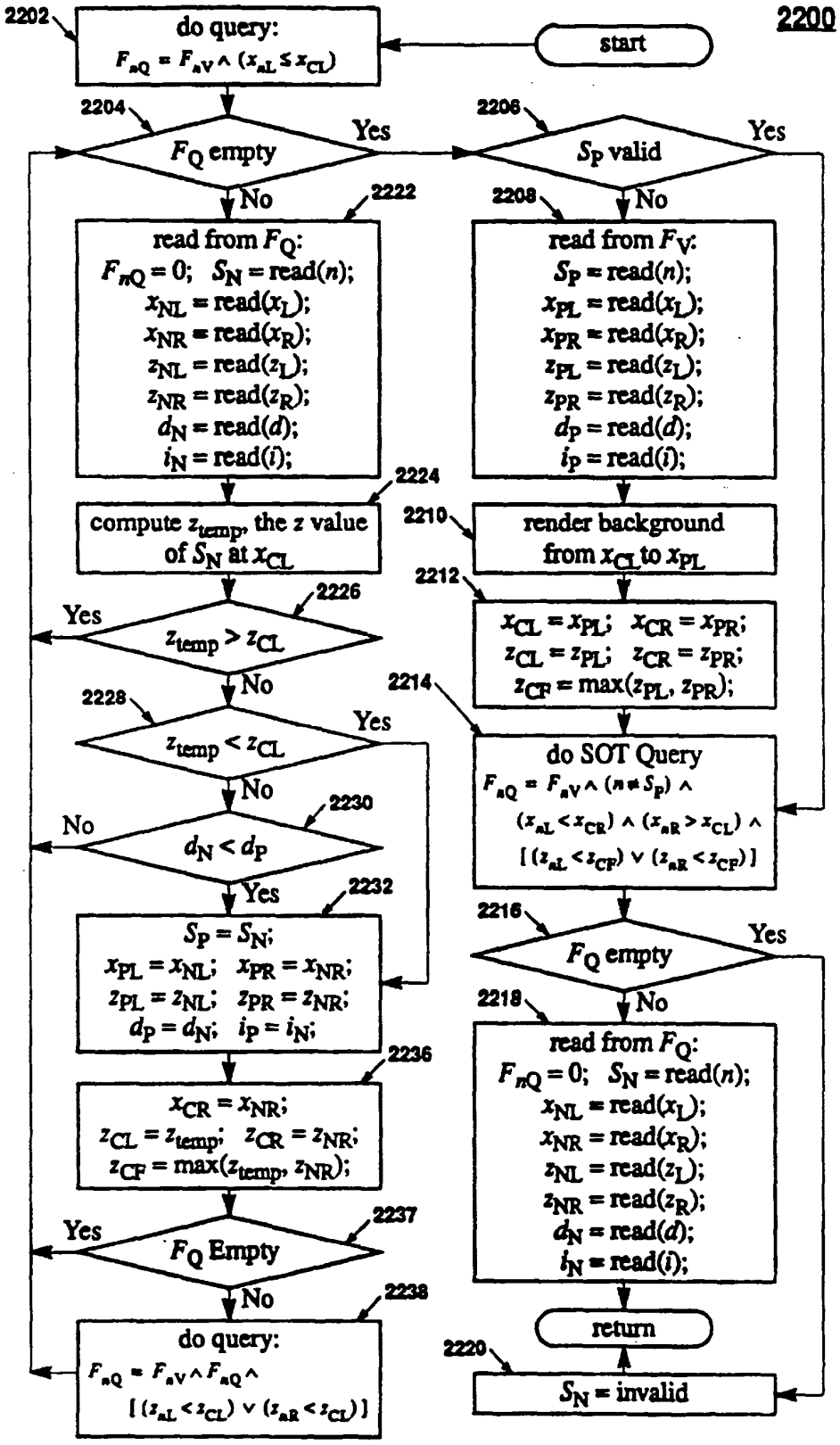


Figure 23 Rule 2 of SSRM

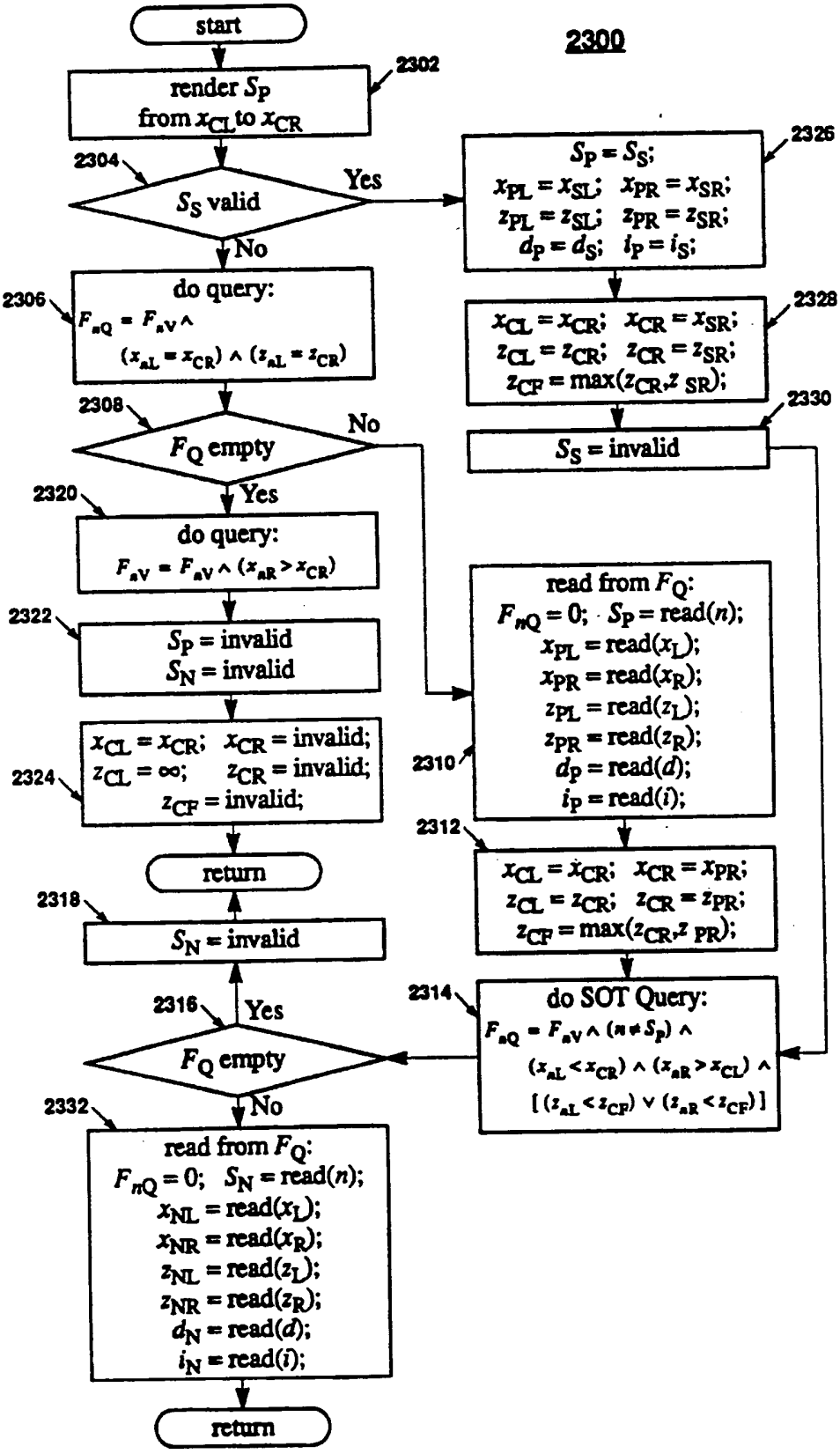


Figure 24 Rule 3 of SSRM

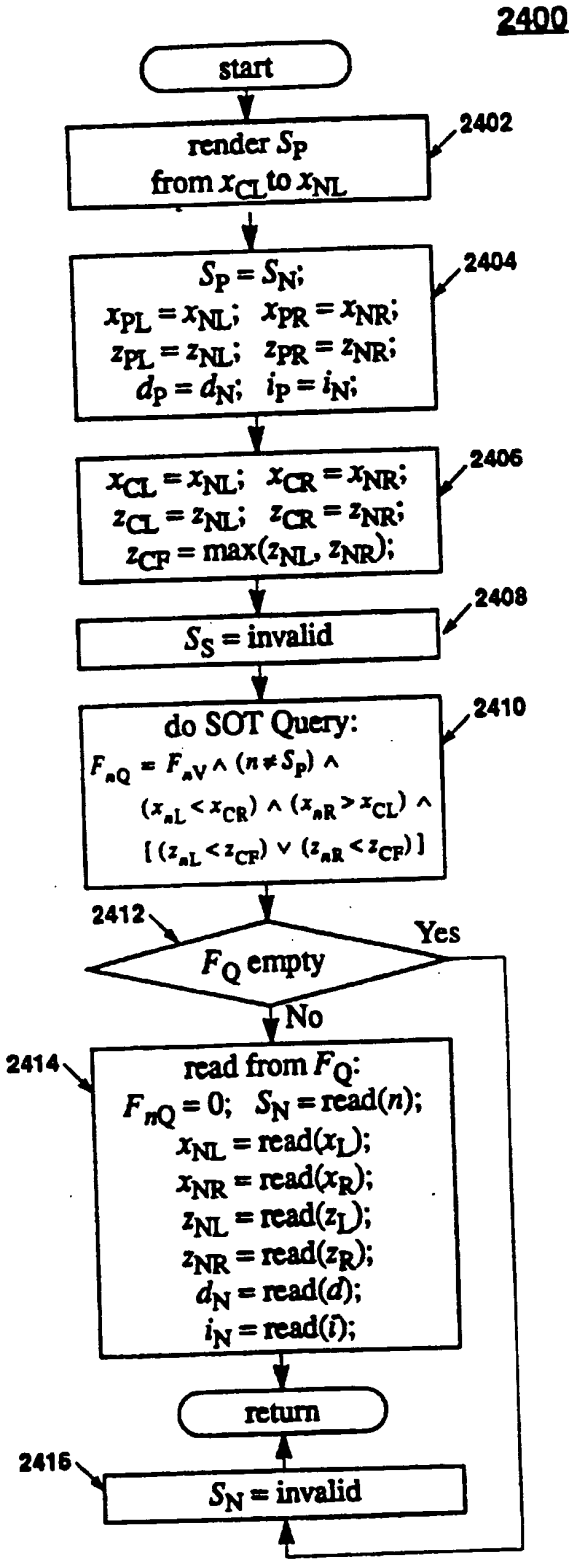


Figure 25 Rule 4 of SSRM

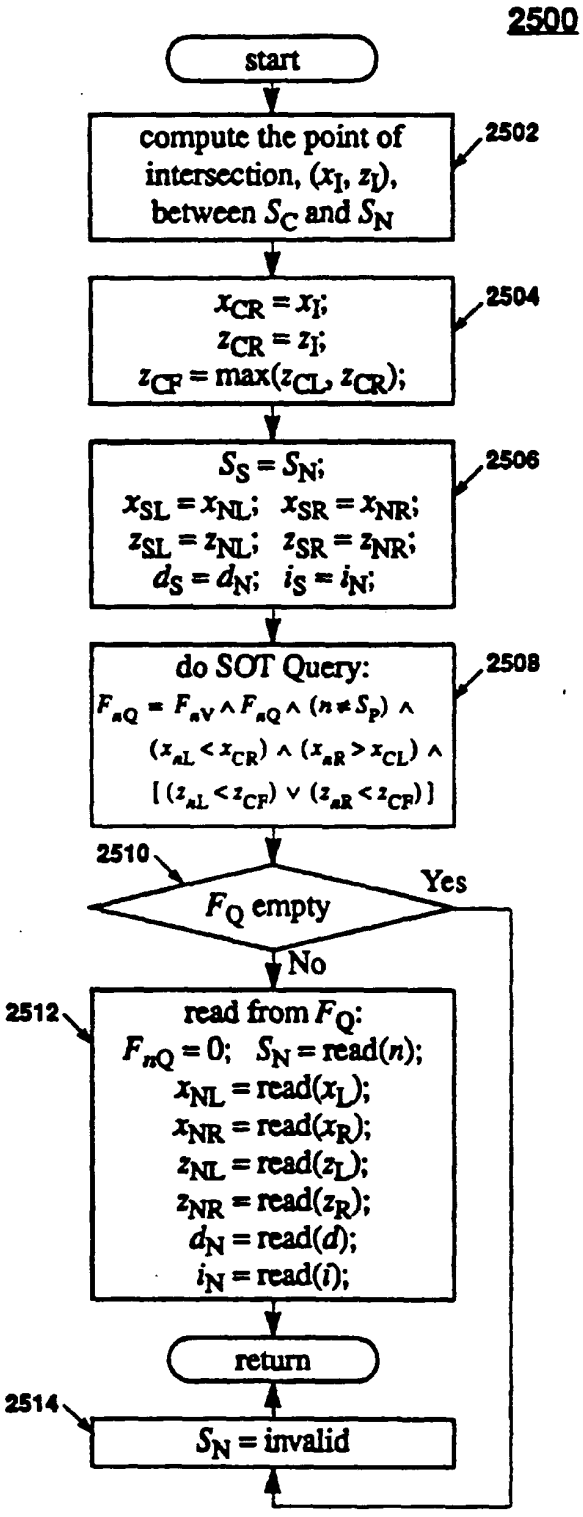


Figure 26 Rule 5 of SSRM

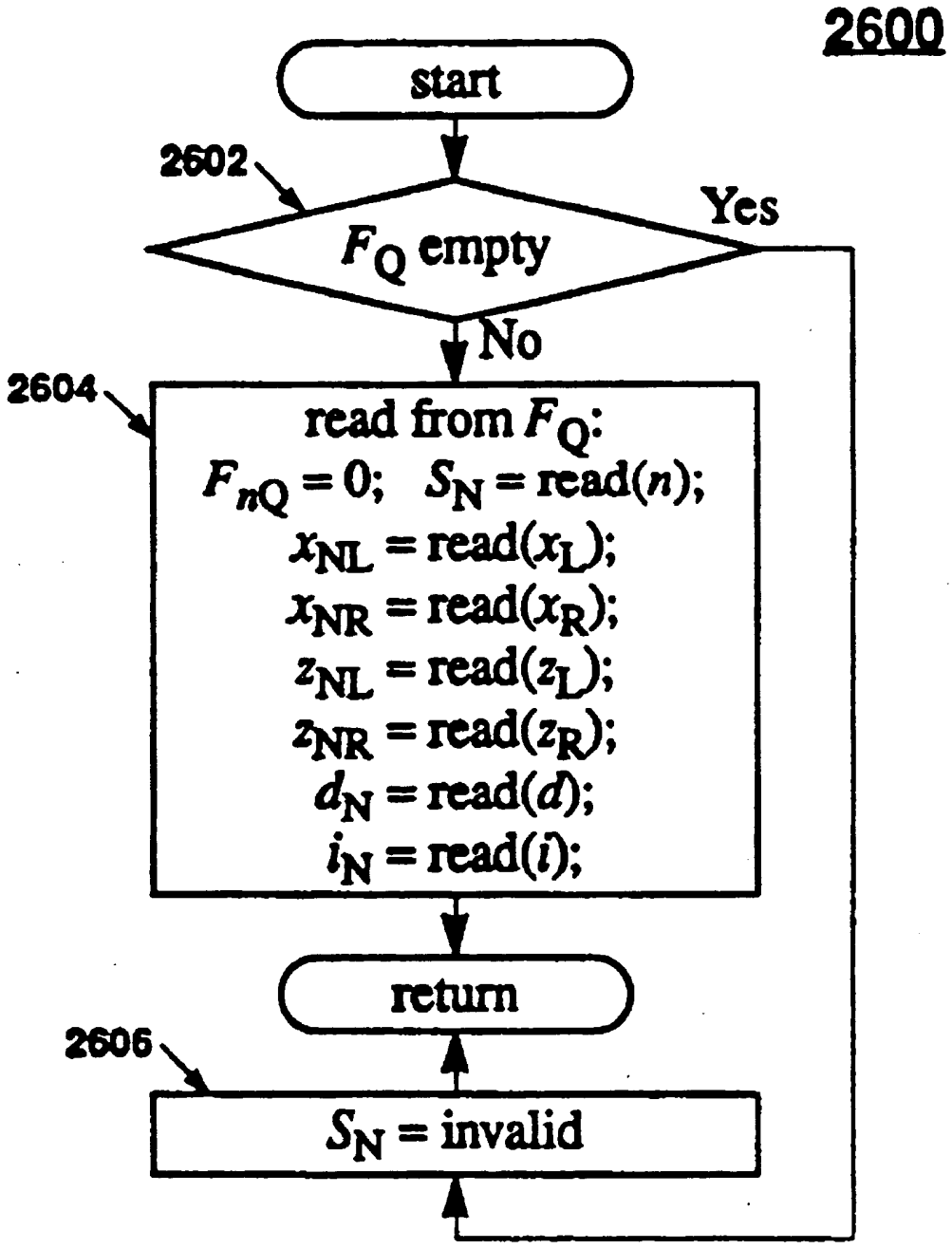


Figure 27 A Set of Spans on One Raster Line, Including Overlapping Bounding Boxes

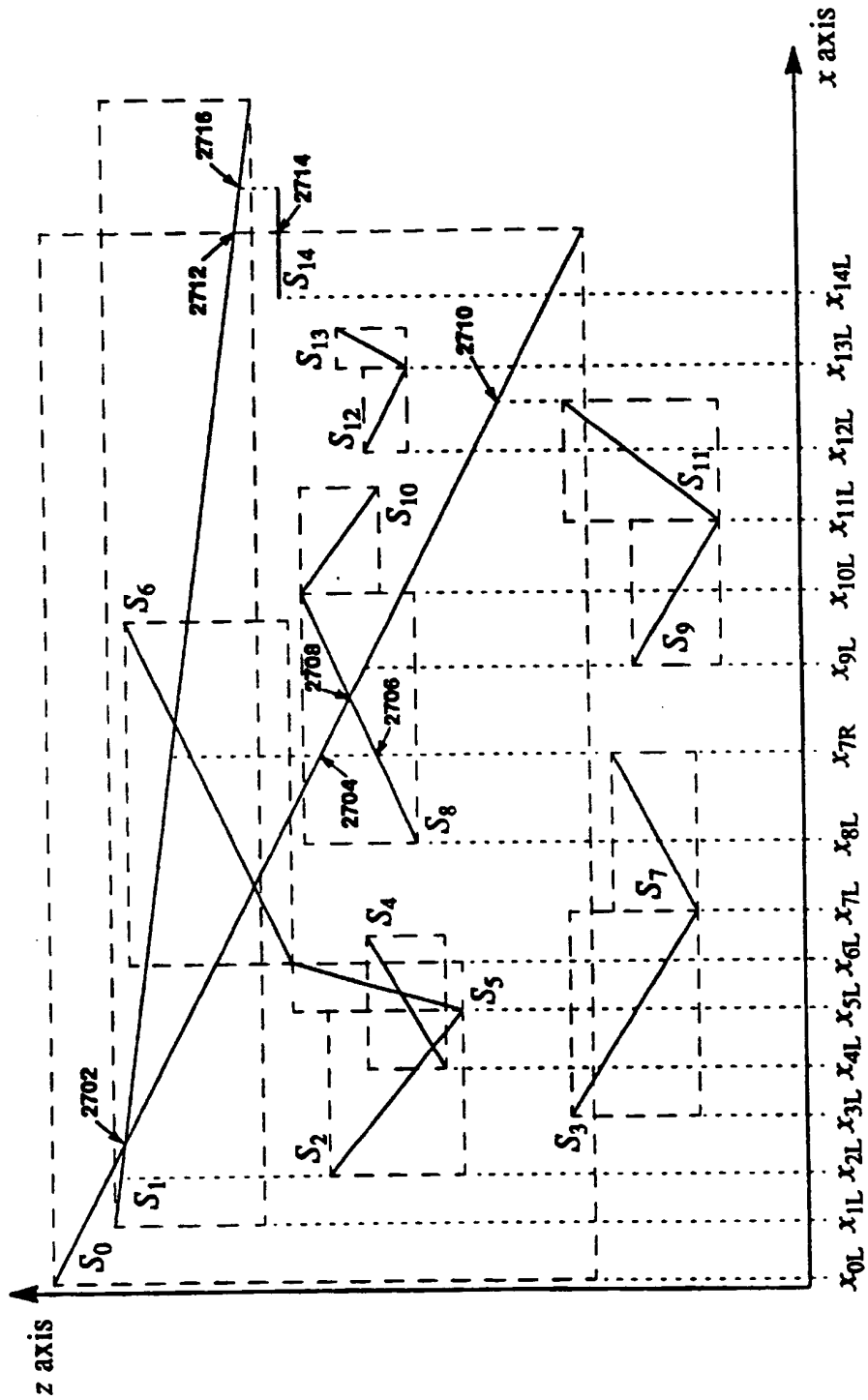


Figure 28 Timing diagram for phase-locked raster line processing and display

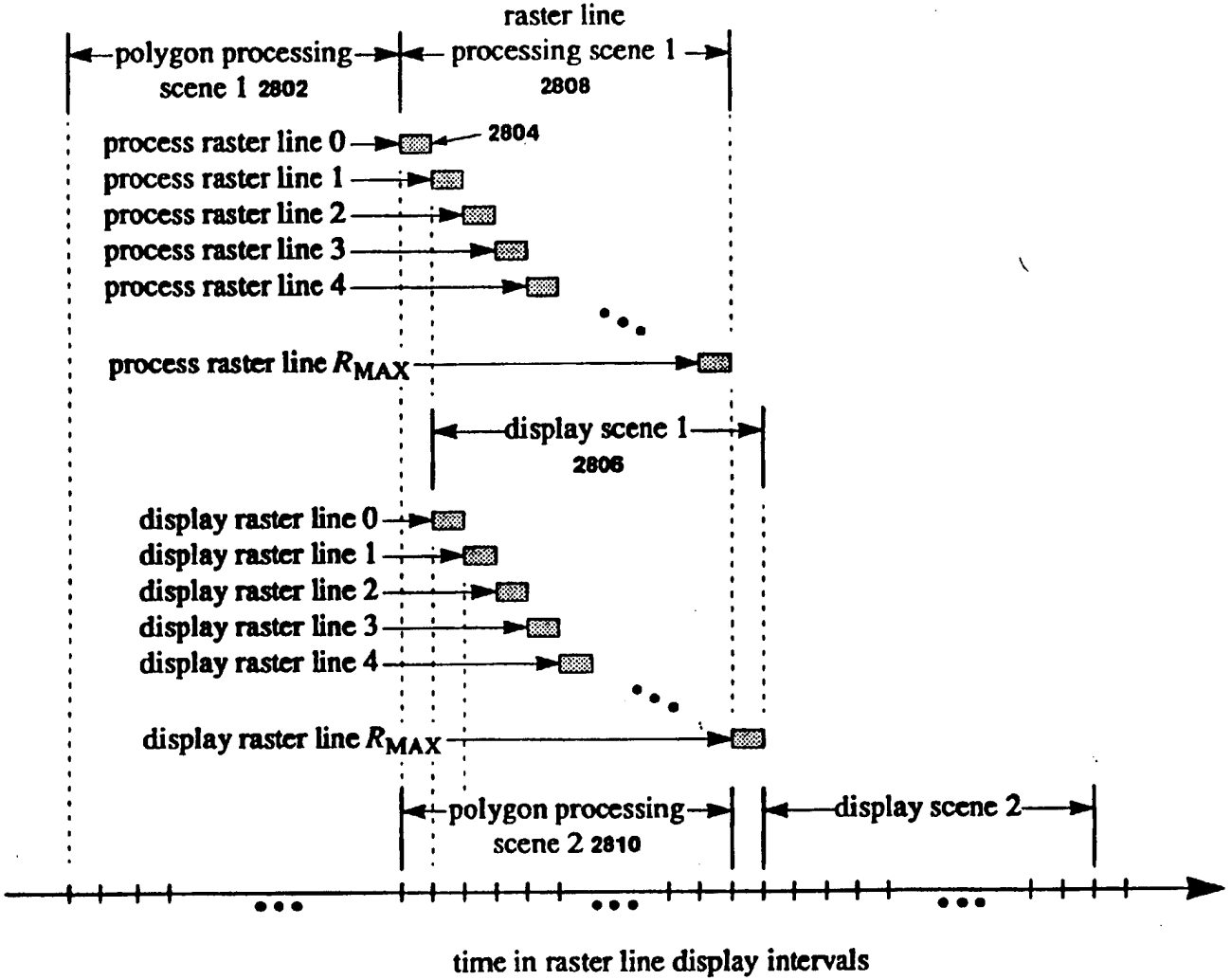


Figure 29 Timing diagram for single buffered frame buffer

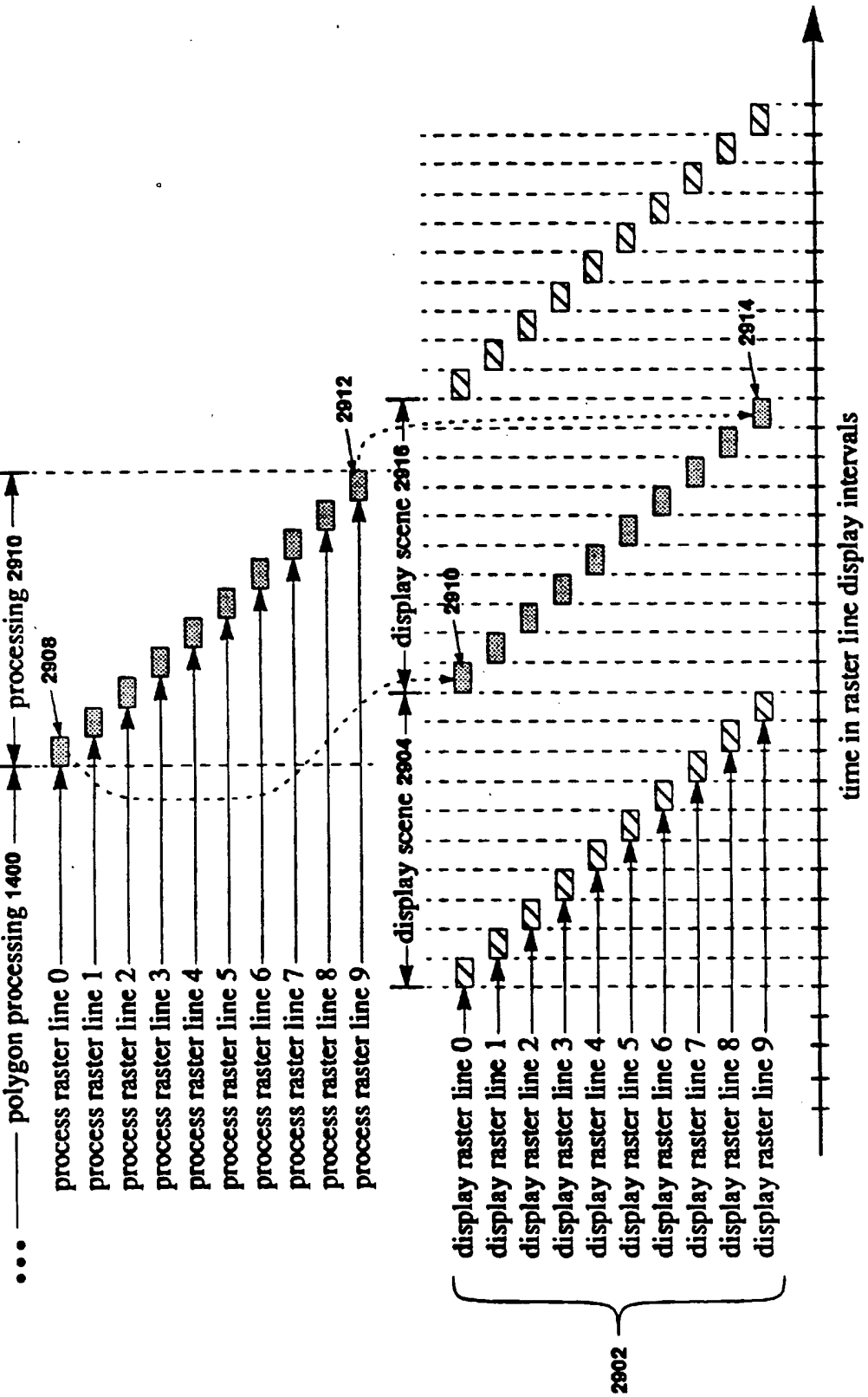
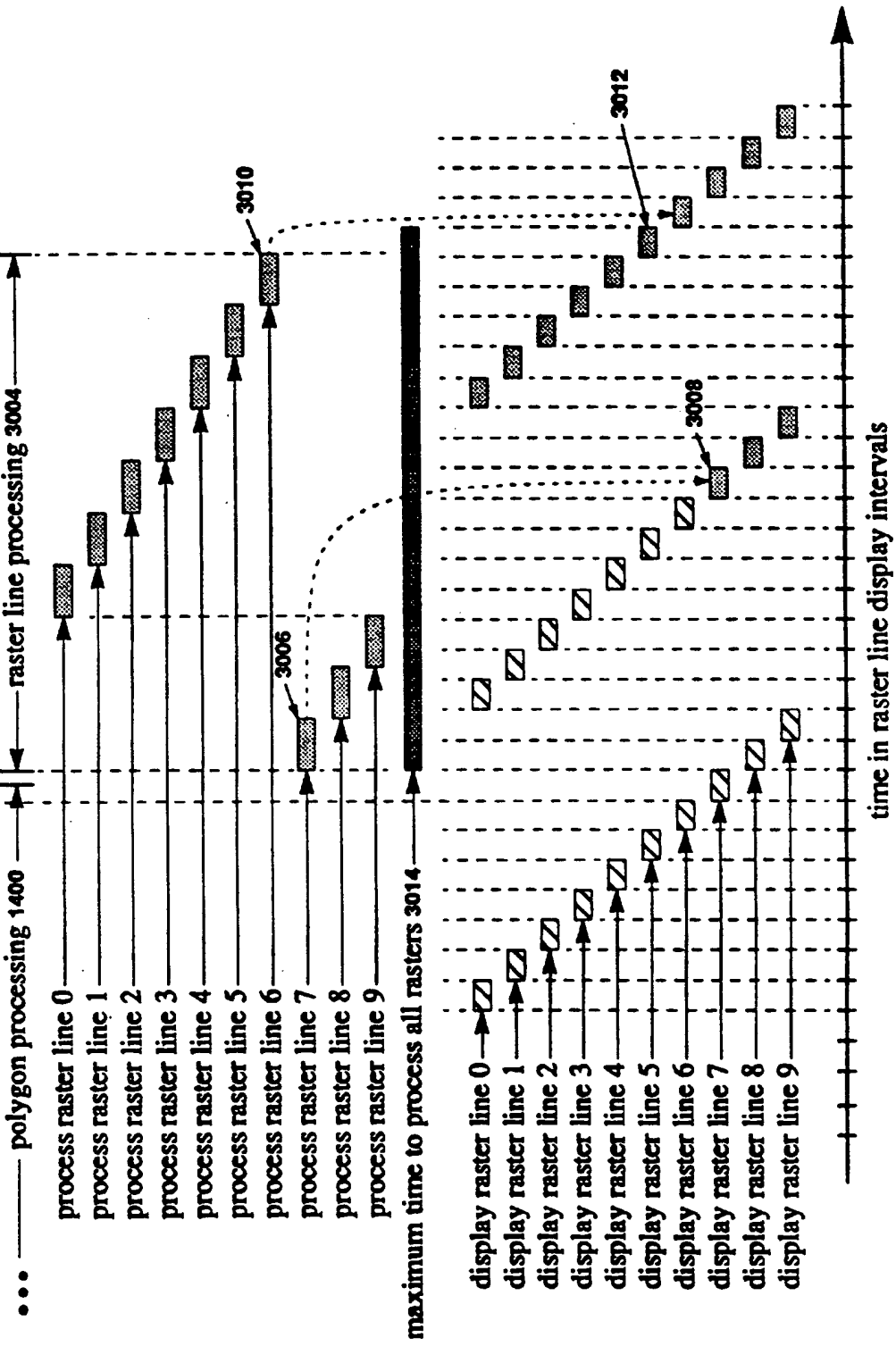


Figure 30 Timing diagram for single buffered frame buffer with slow rasterization



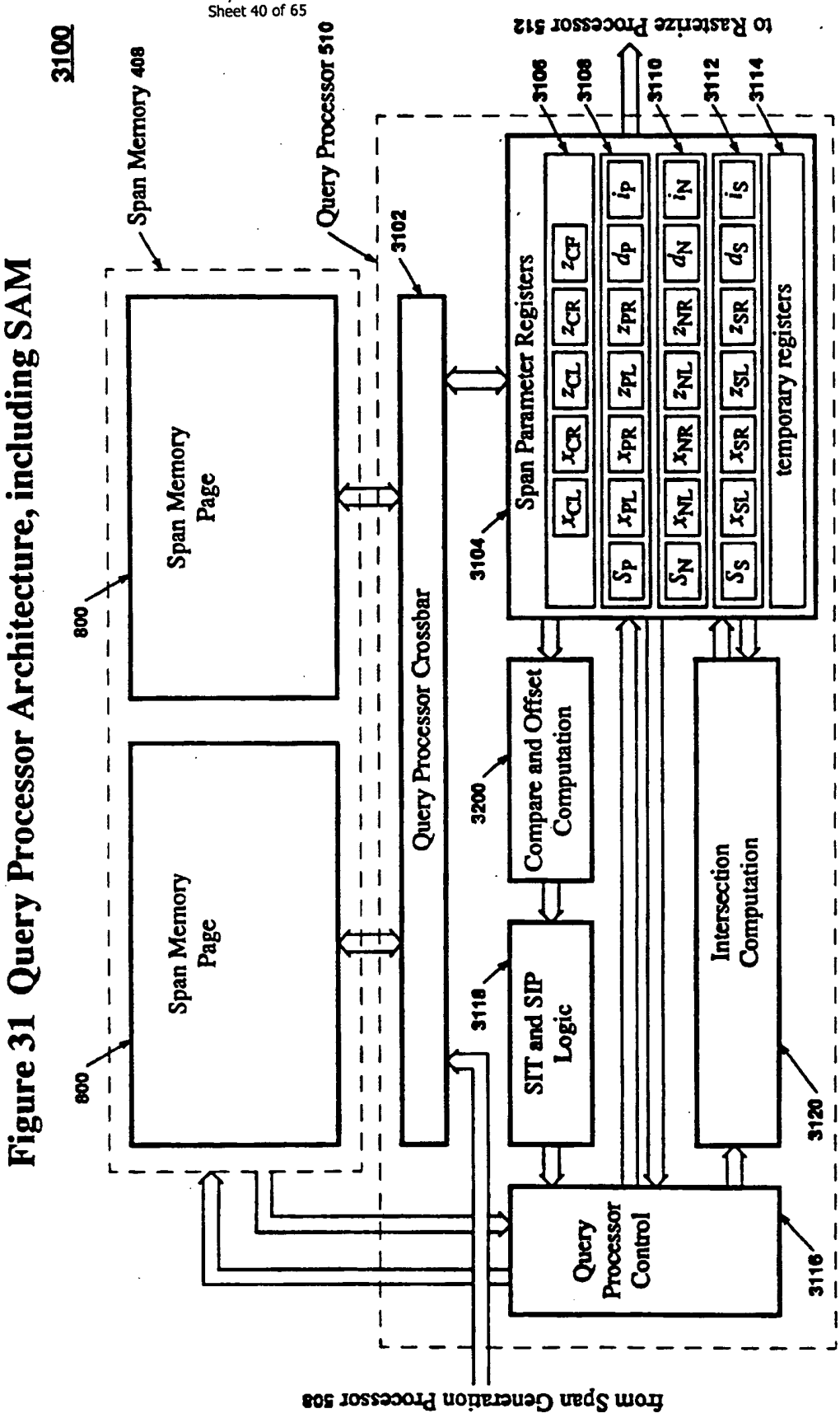


Figure 31 Query Processor Architecture, including SAM

Figure 32 Comparison and Offset Computation

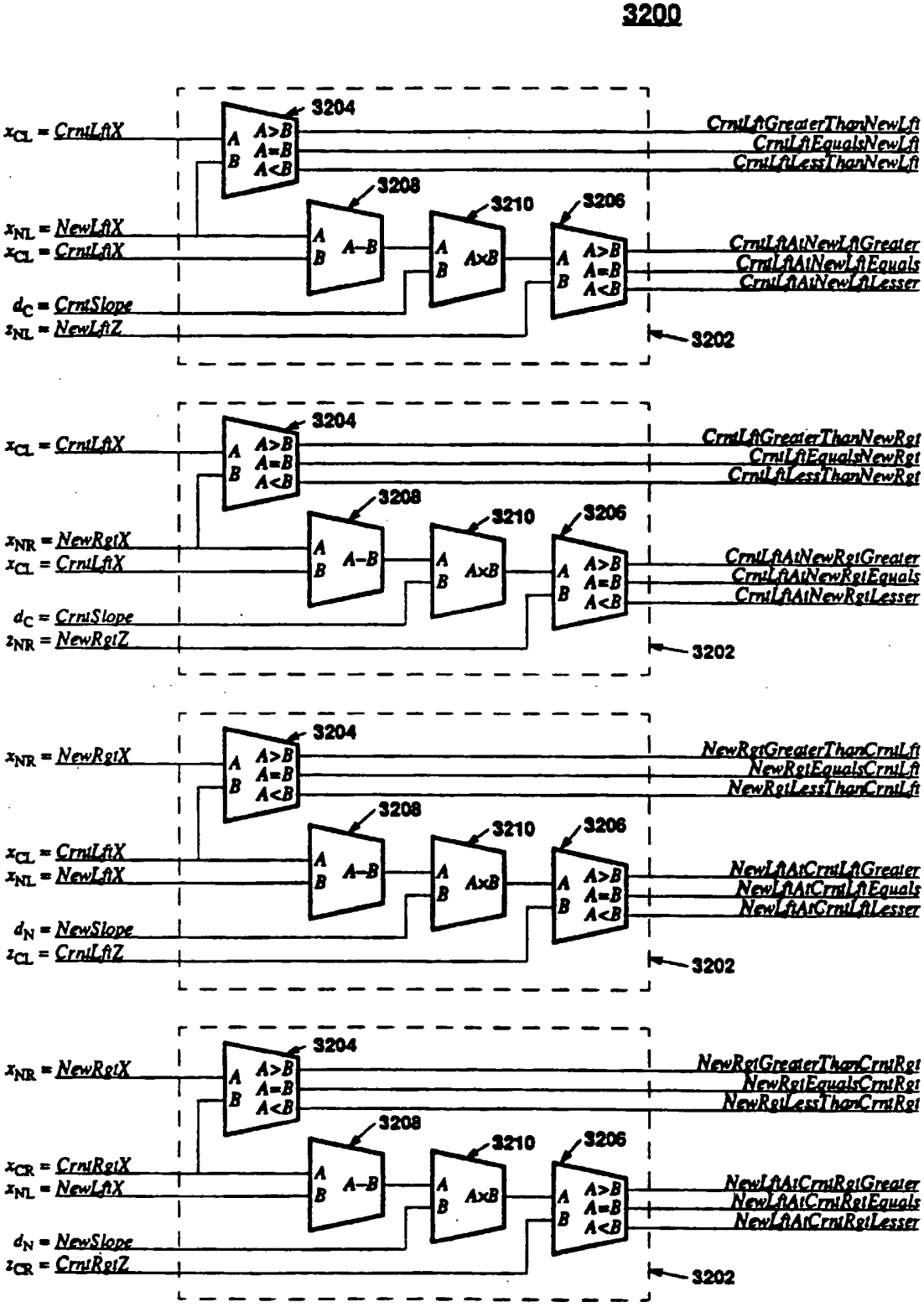


Figure 33 Prior Art MCCAM Cell

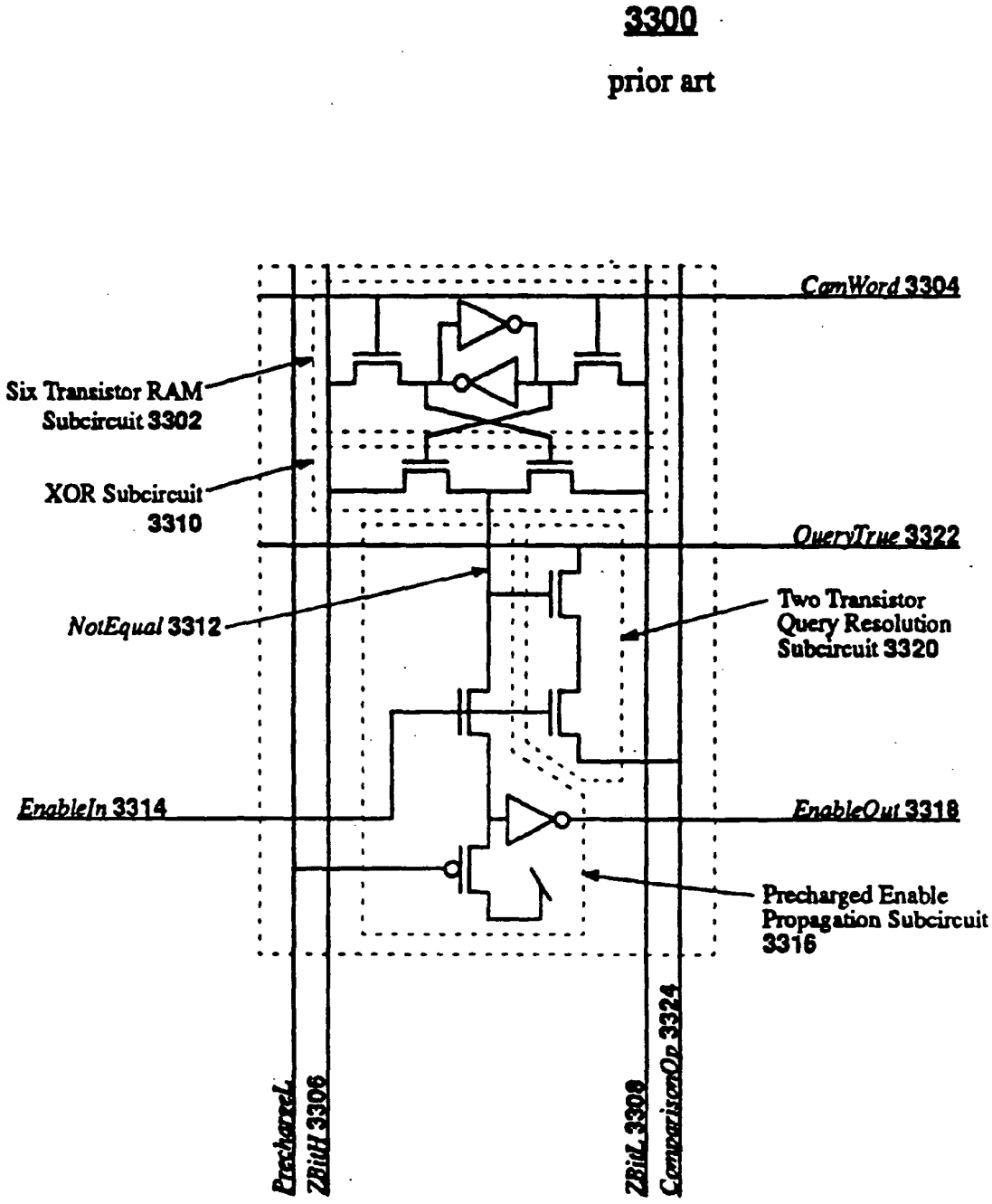


Figure 34 Generic SMCCAM Cell

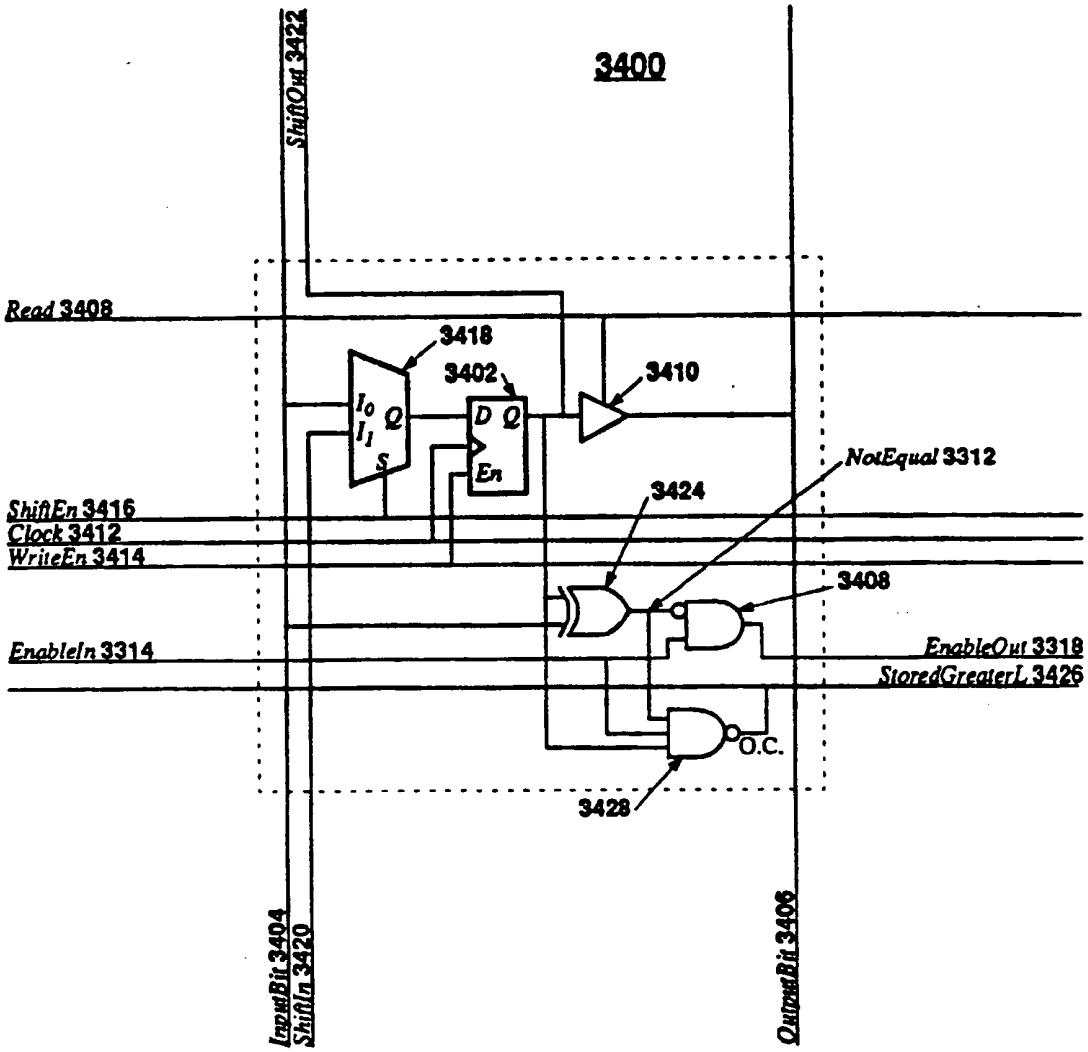


Figure 35 Static SMCCAM Cell

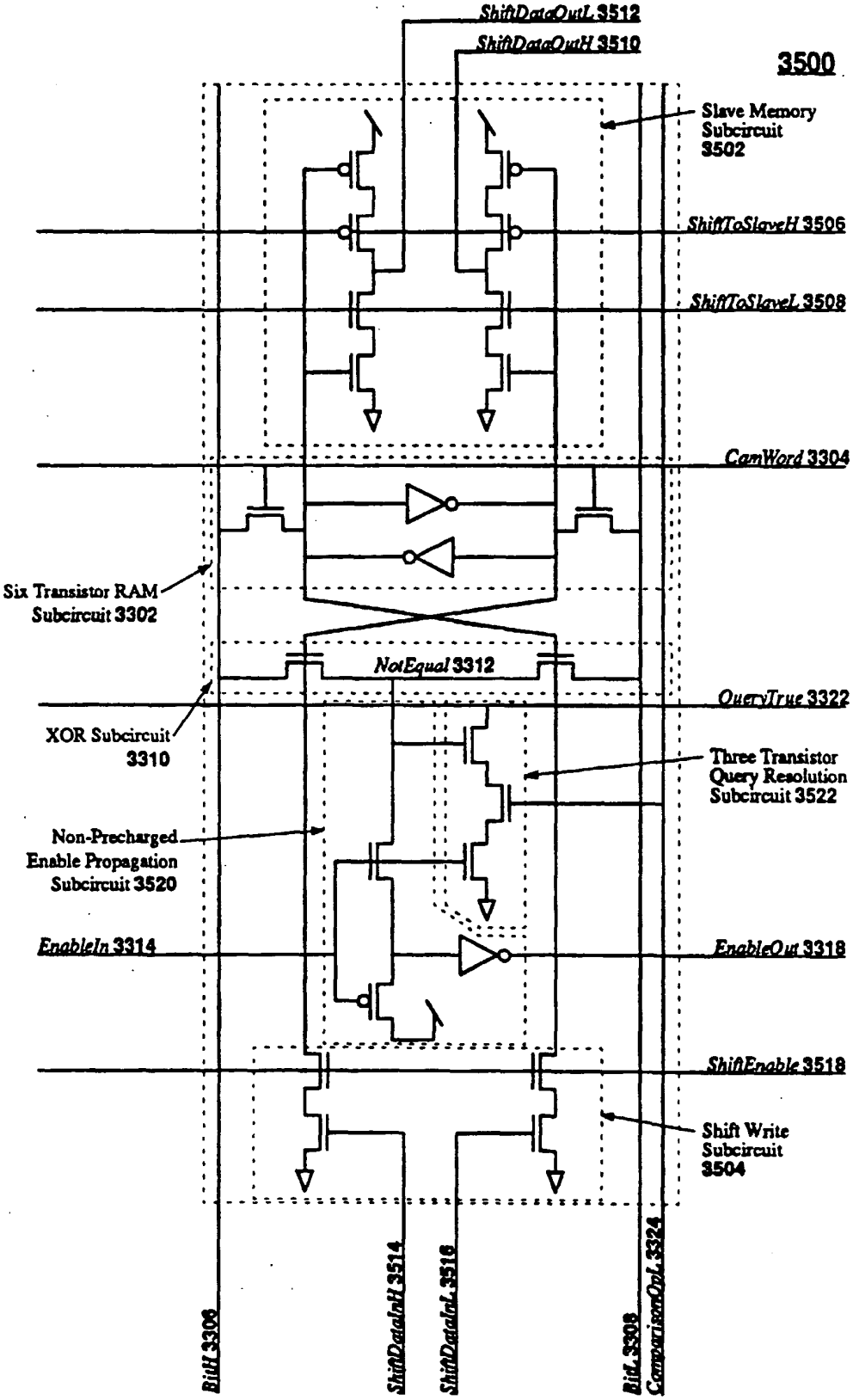


Figure 36 Dynamic SMCCAM Cell

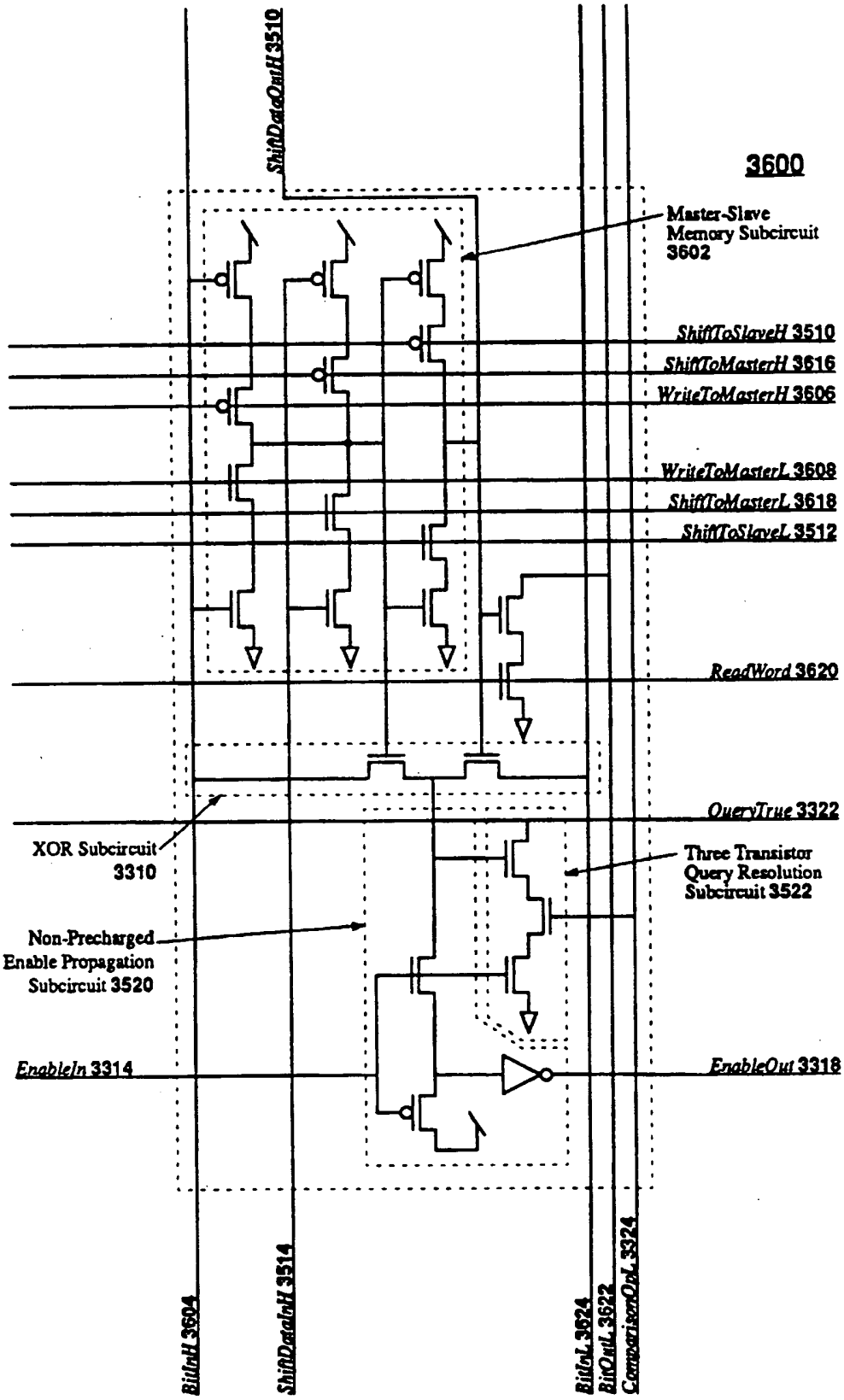


Figure 37 Array of SAM Cells

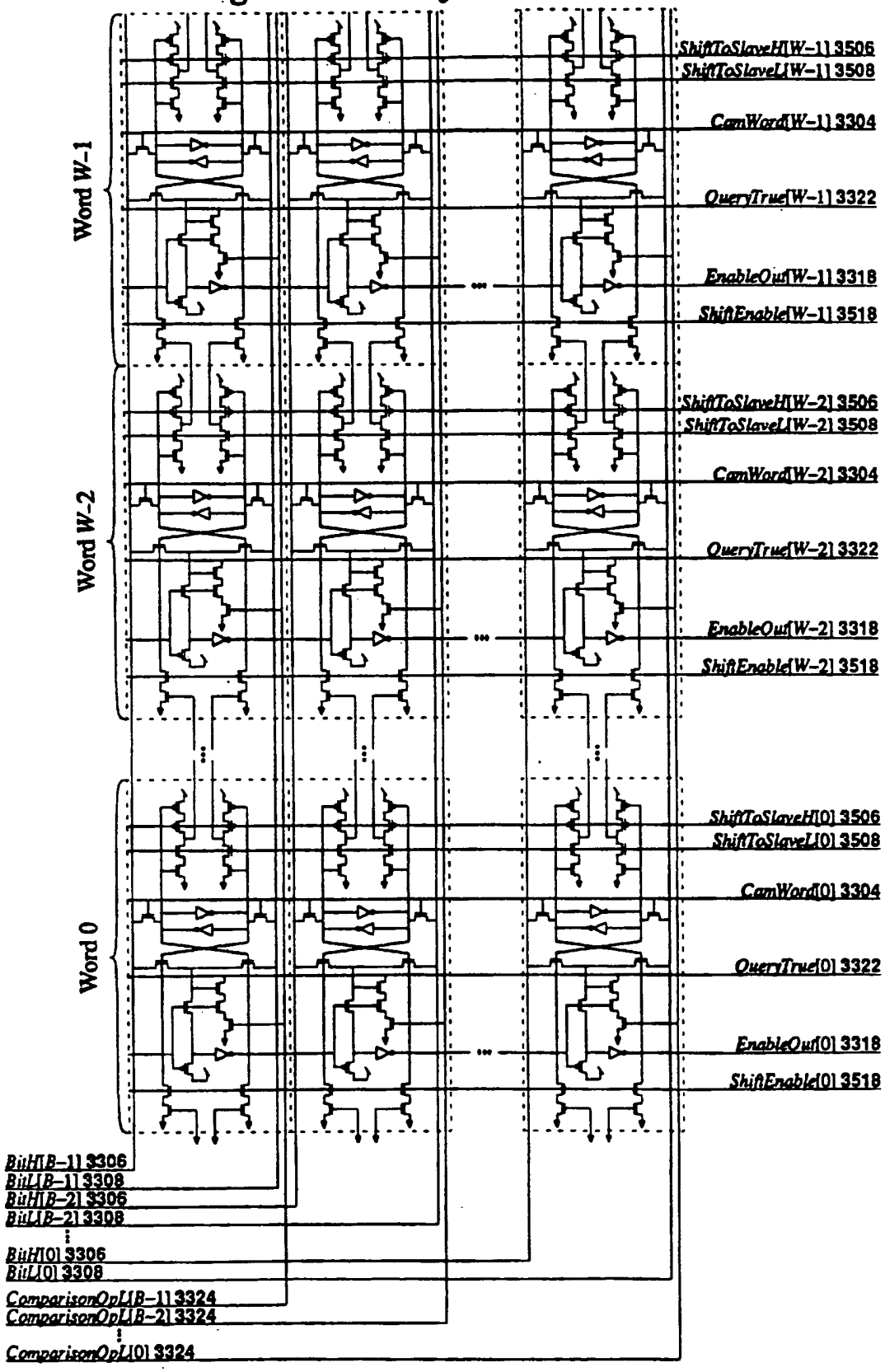


Figure 38 Multiple Spans Vertically within a Raster Line

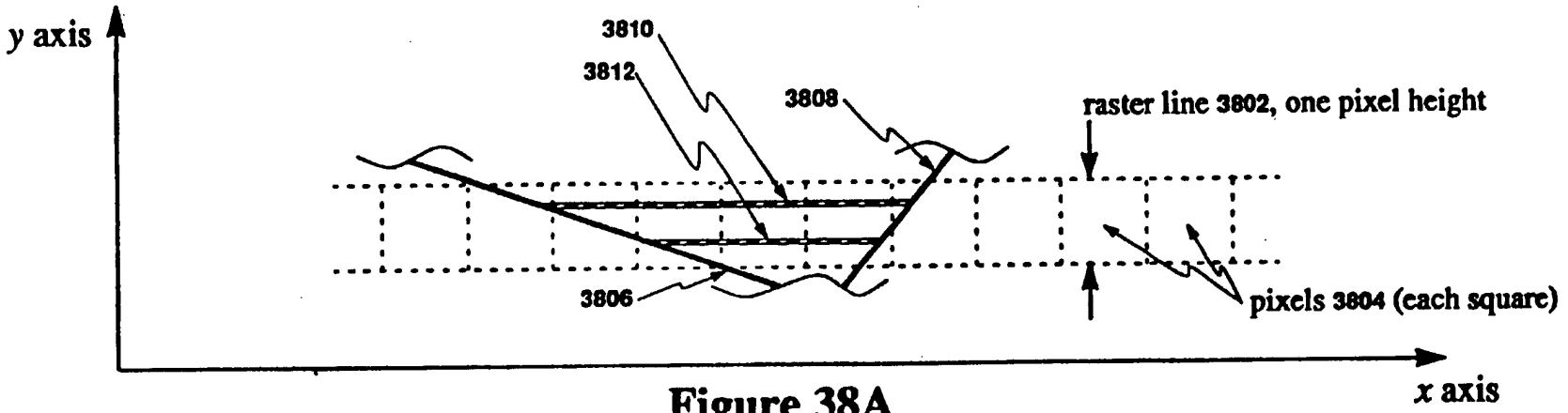


Figure 38A

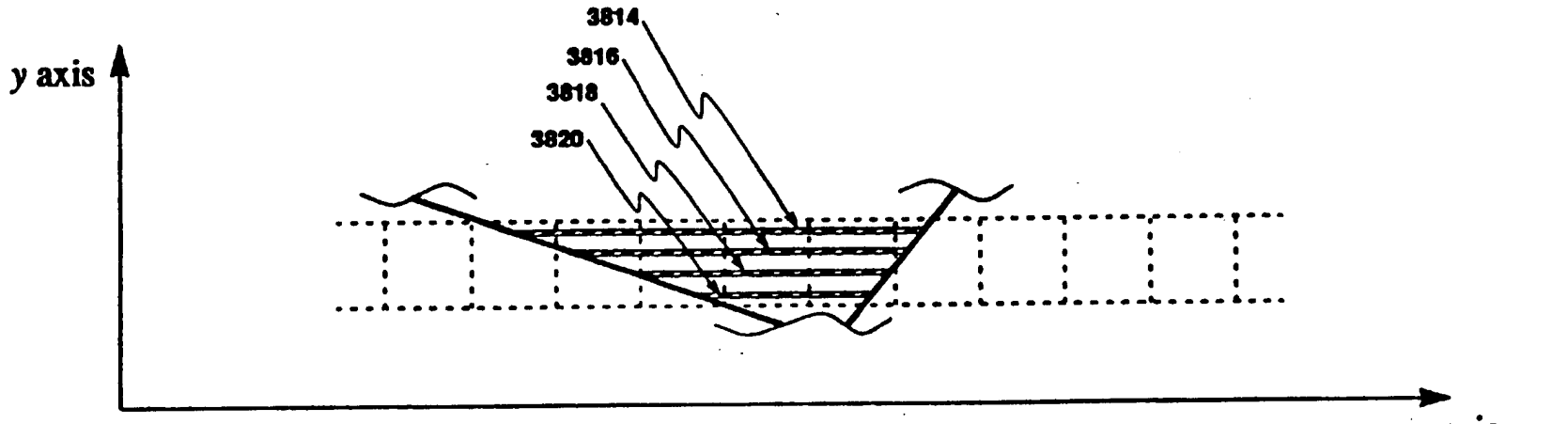


Figure 38B

Figure 39 SMCCAM Processing Solves Both Antialiasing and Hidden Surface Removal

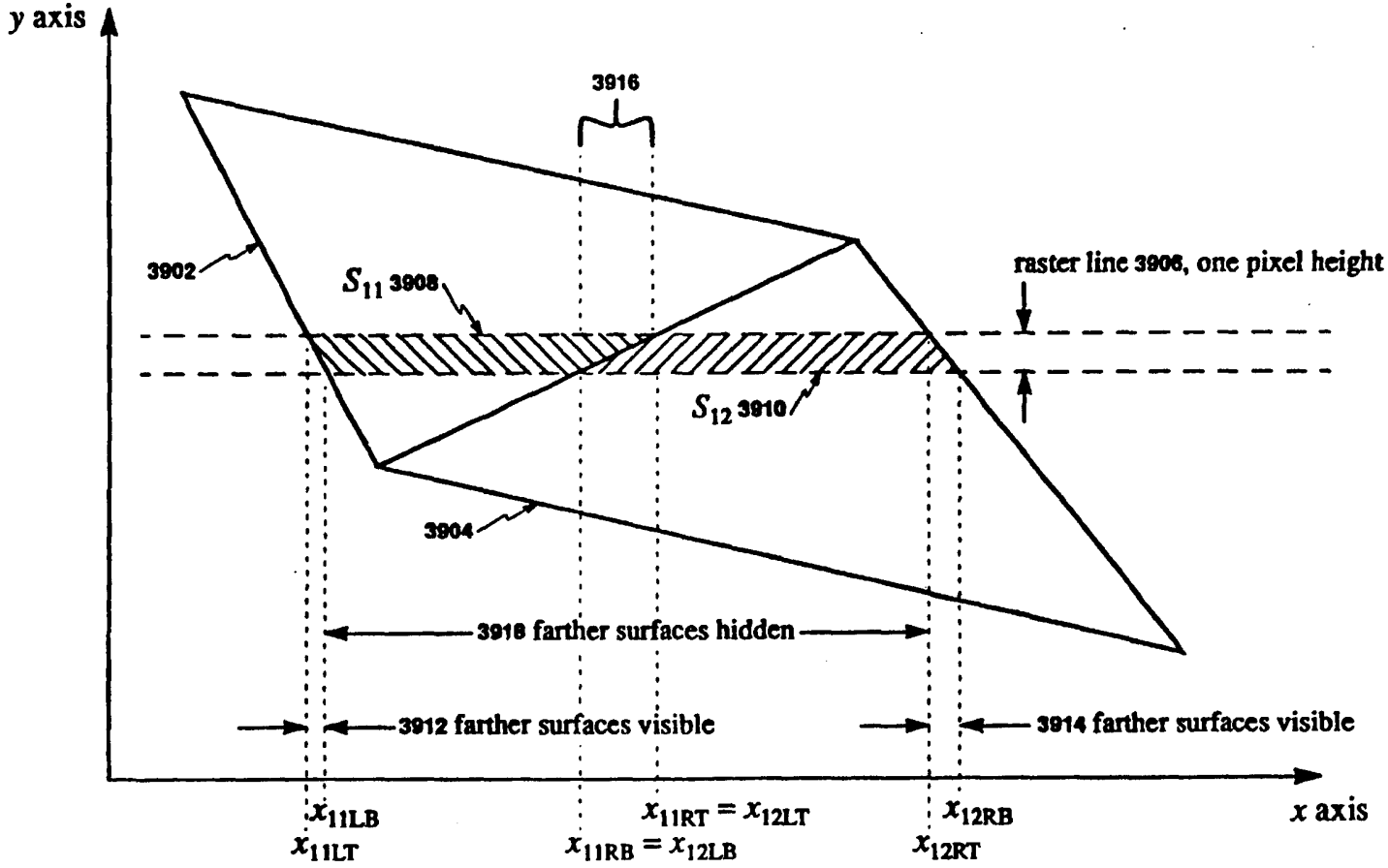


Figure 40 A Set of Trapezoidal Spans on one Raster Line

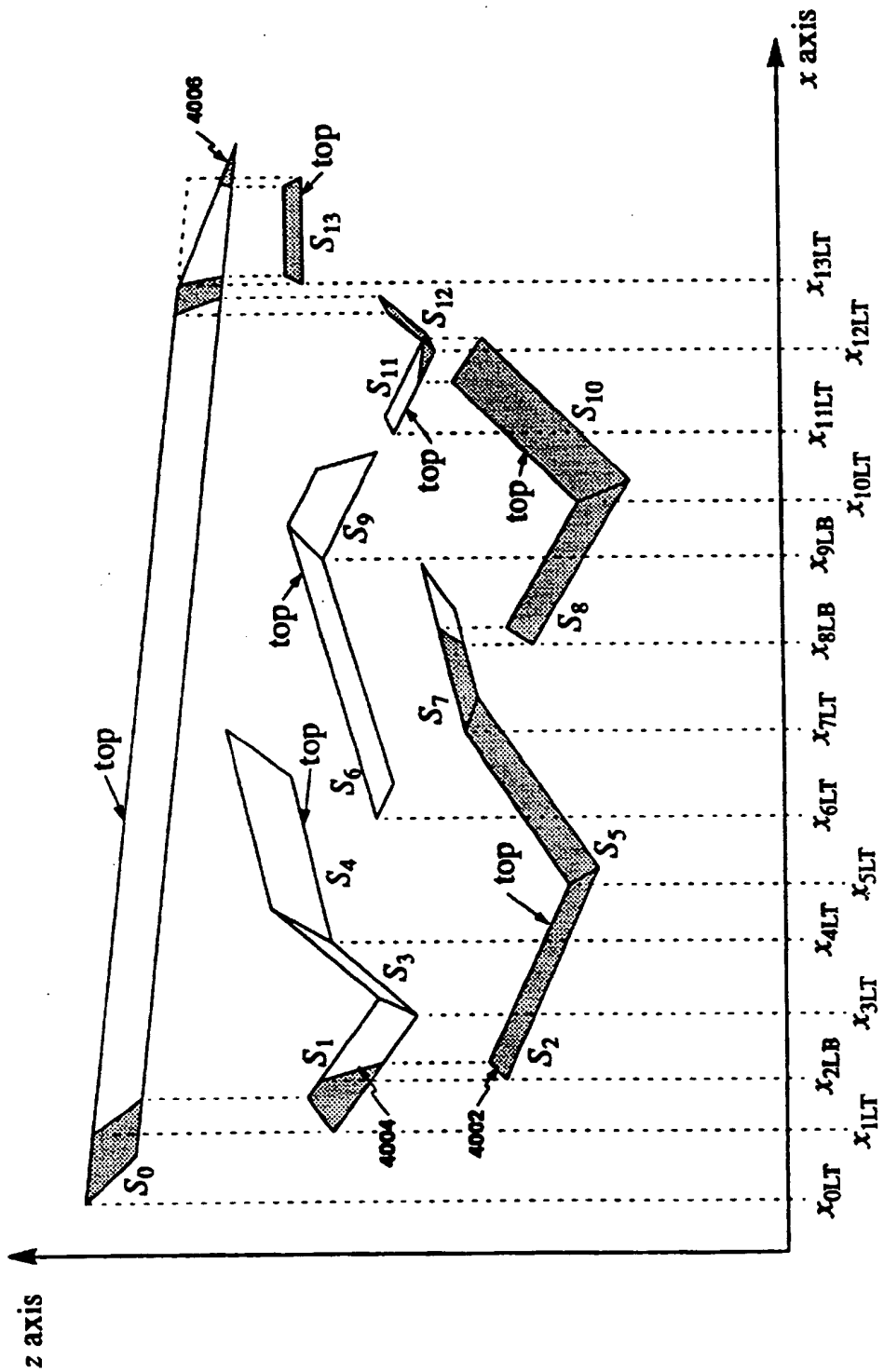


Figure 41 SOT Query for Processing Top and Bottom Separately

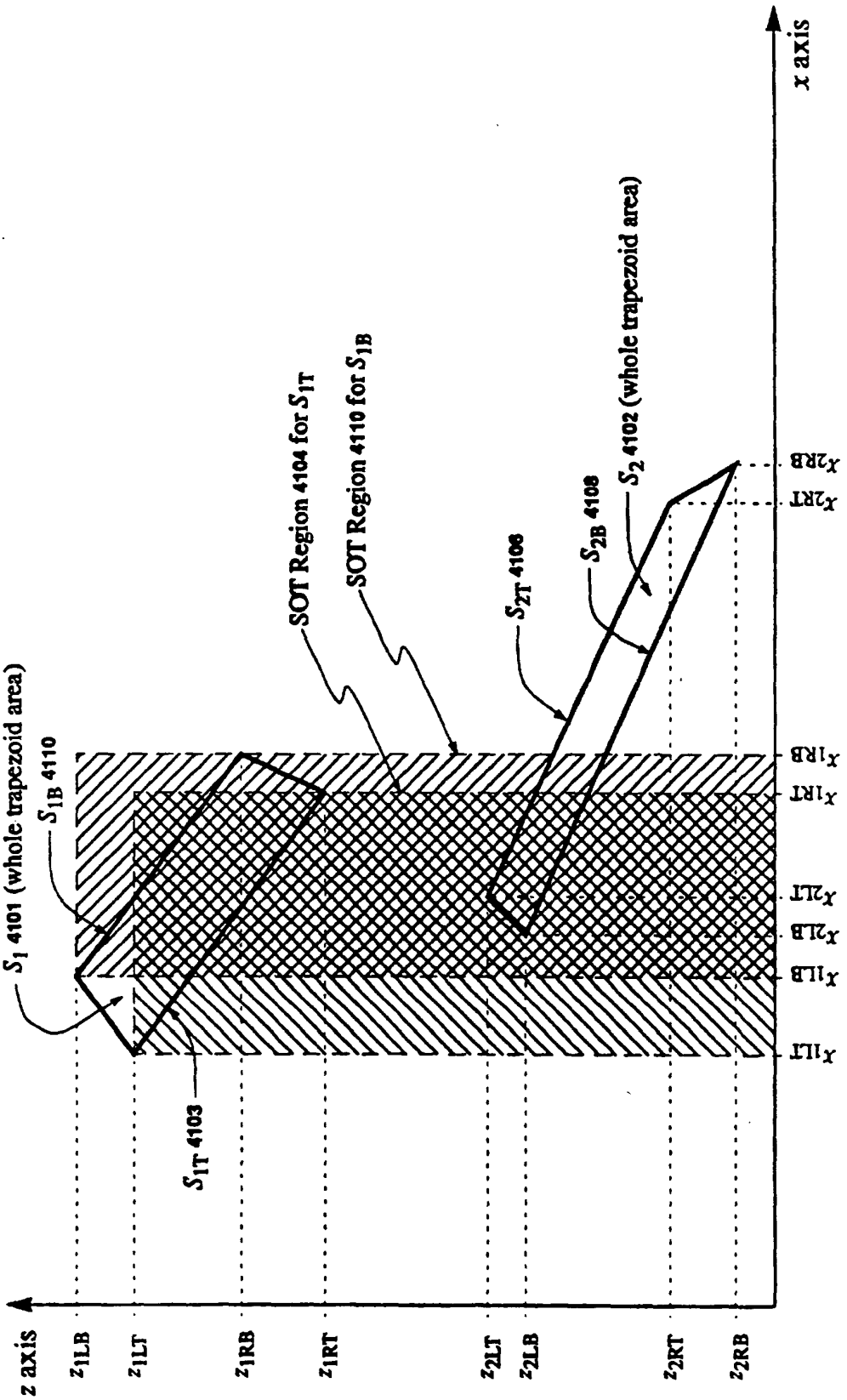
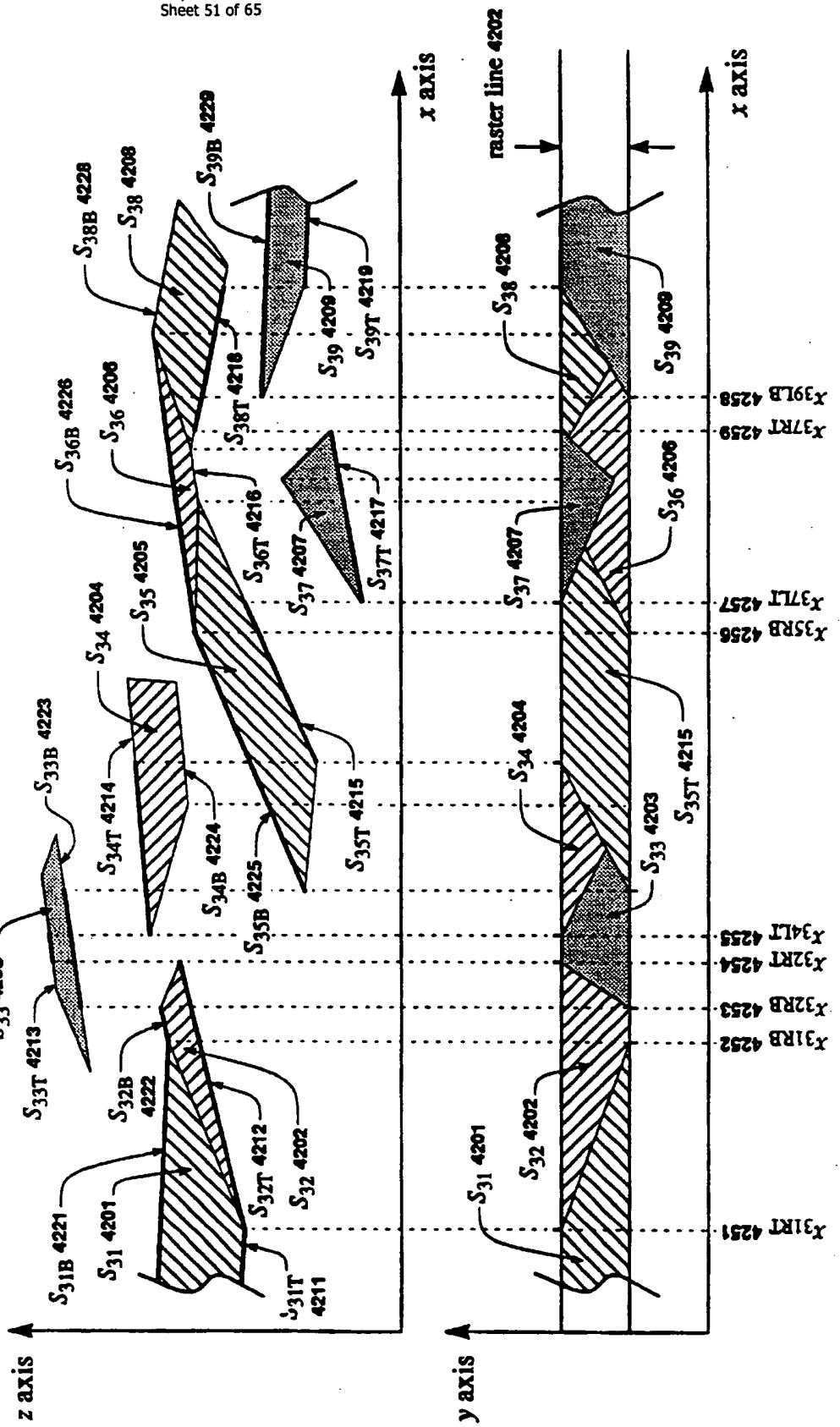


Figure 42 Rasterization Using Span Tops and Span Bottoms



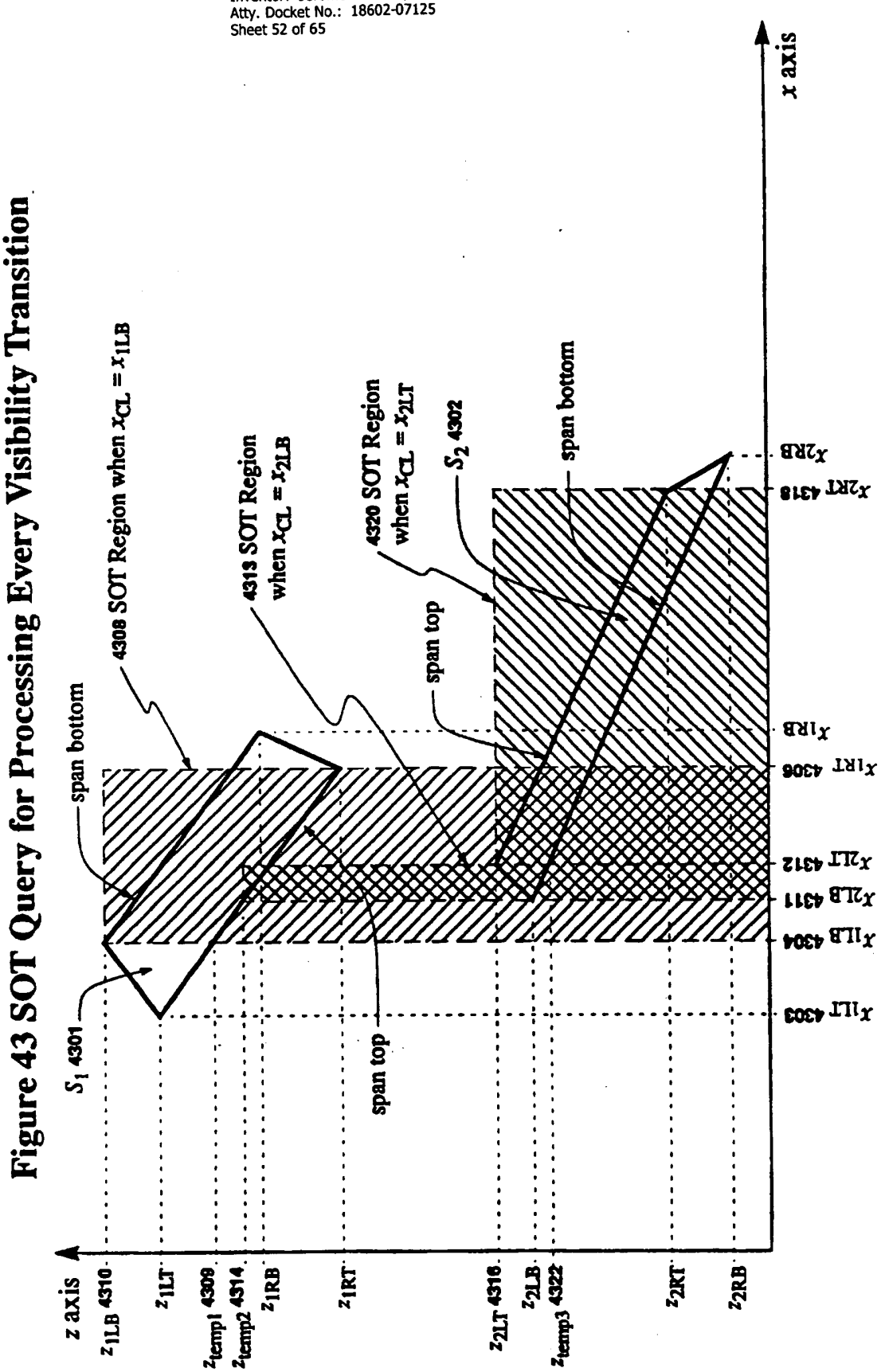


Figure 43 SOT Query for Processing Every Visibility Transition

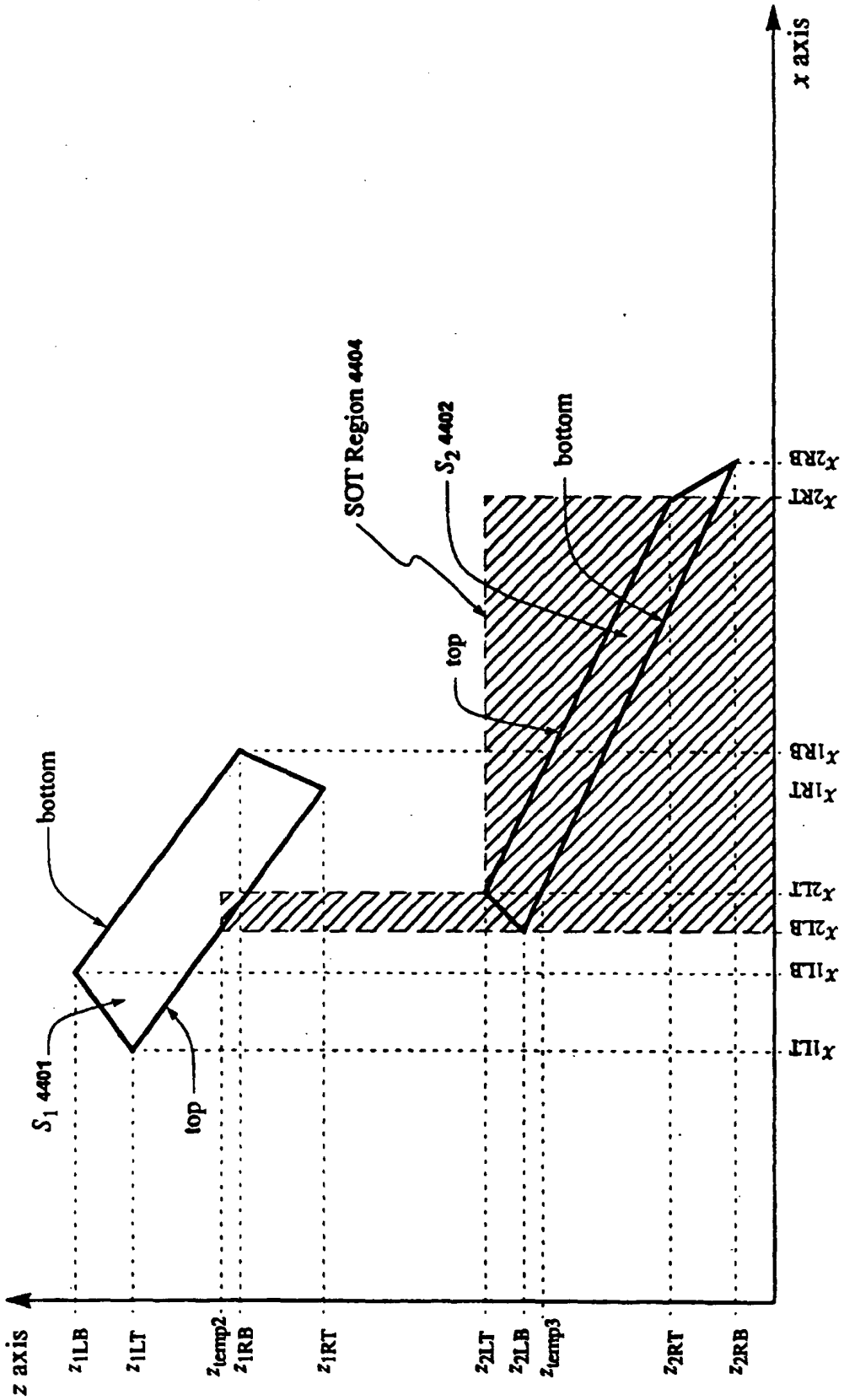


Figure 44 SOT Query with Complex Shape

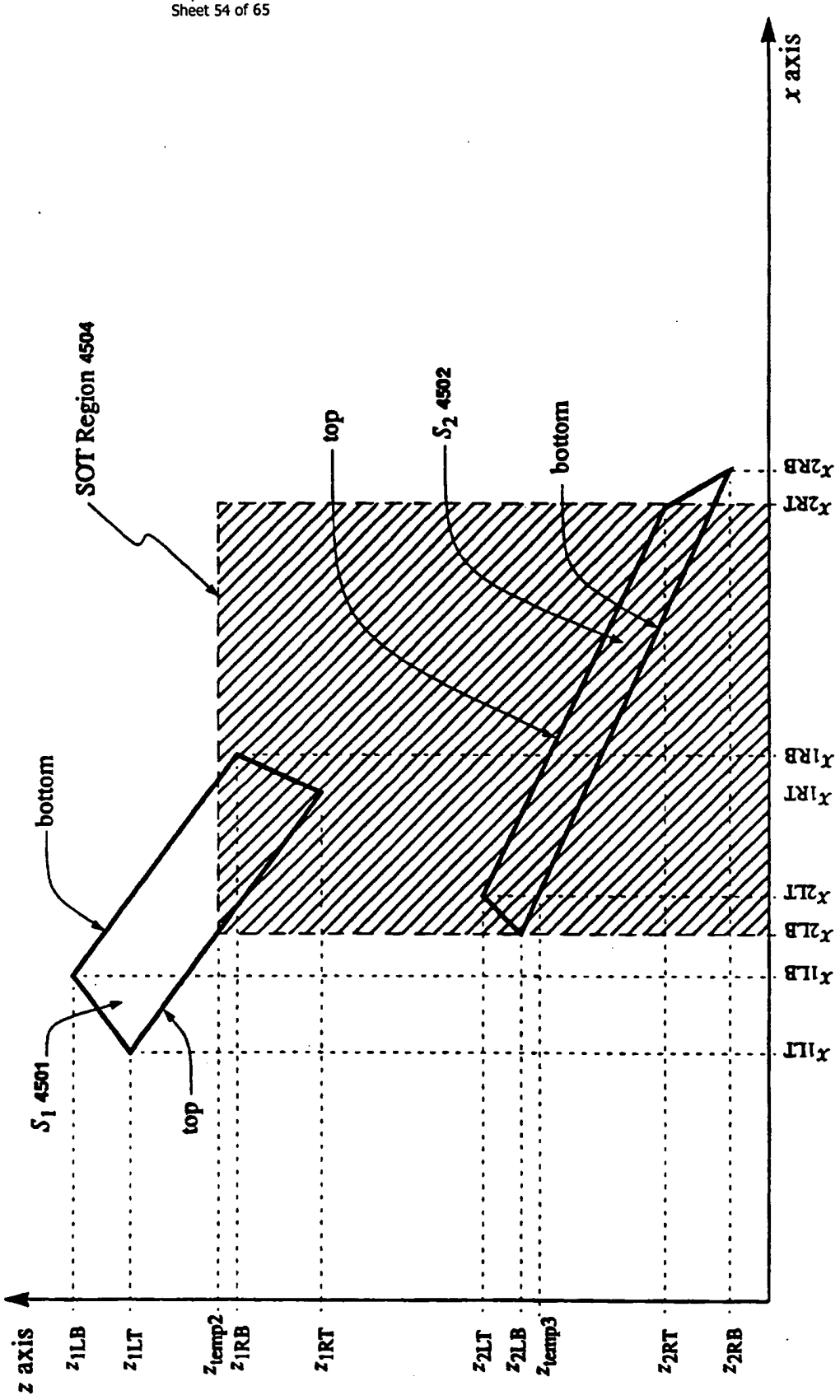
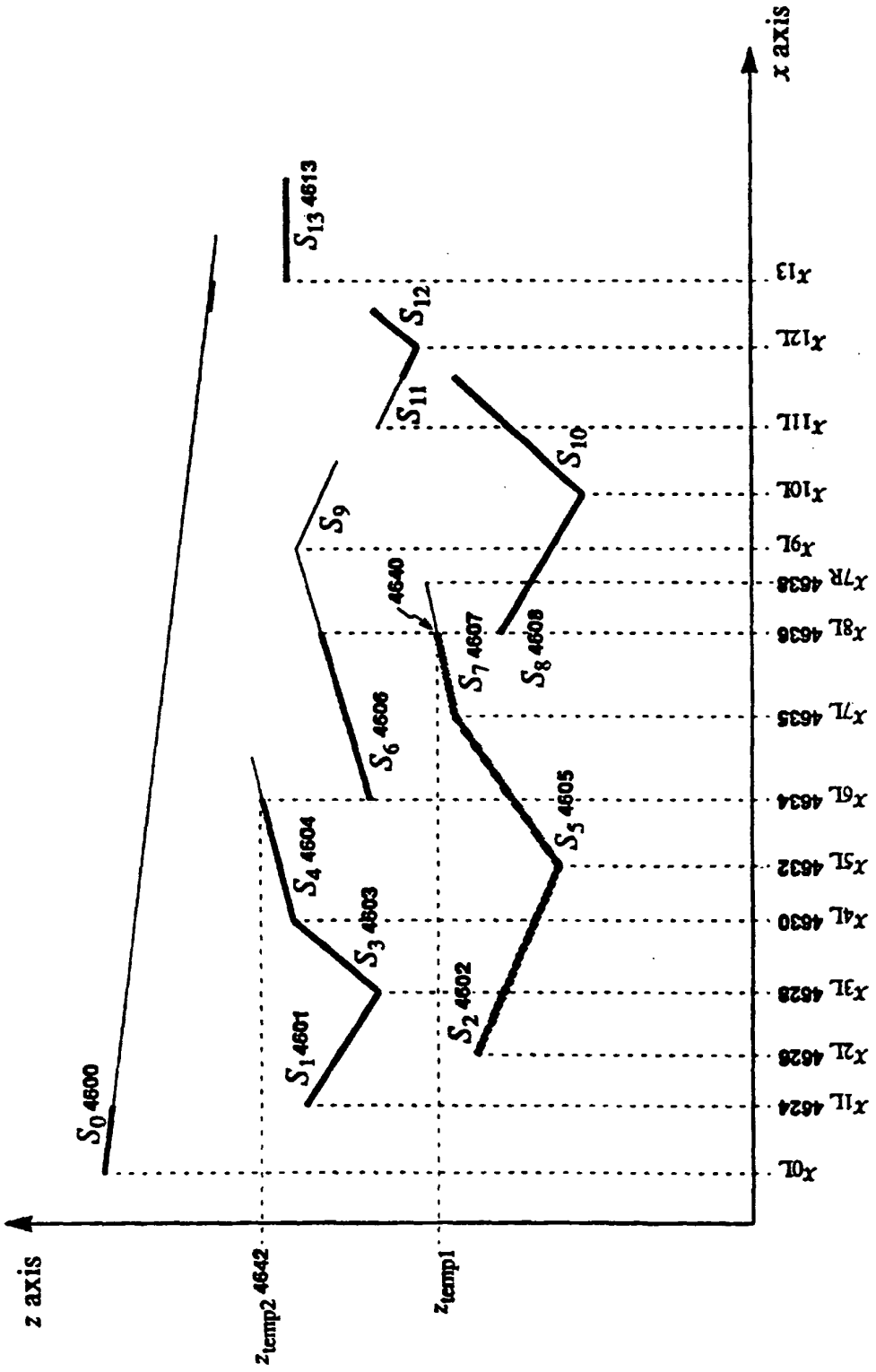


Figure 45 SOT Query with Wider Search Area

Figure 46 A Set of Spans on One Raster Line, Showing Visible Span Portions



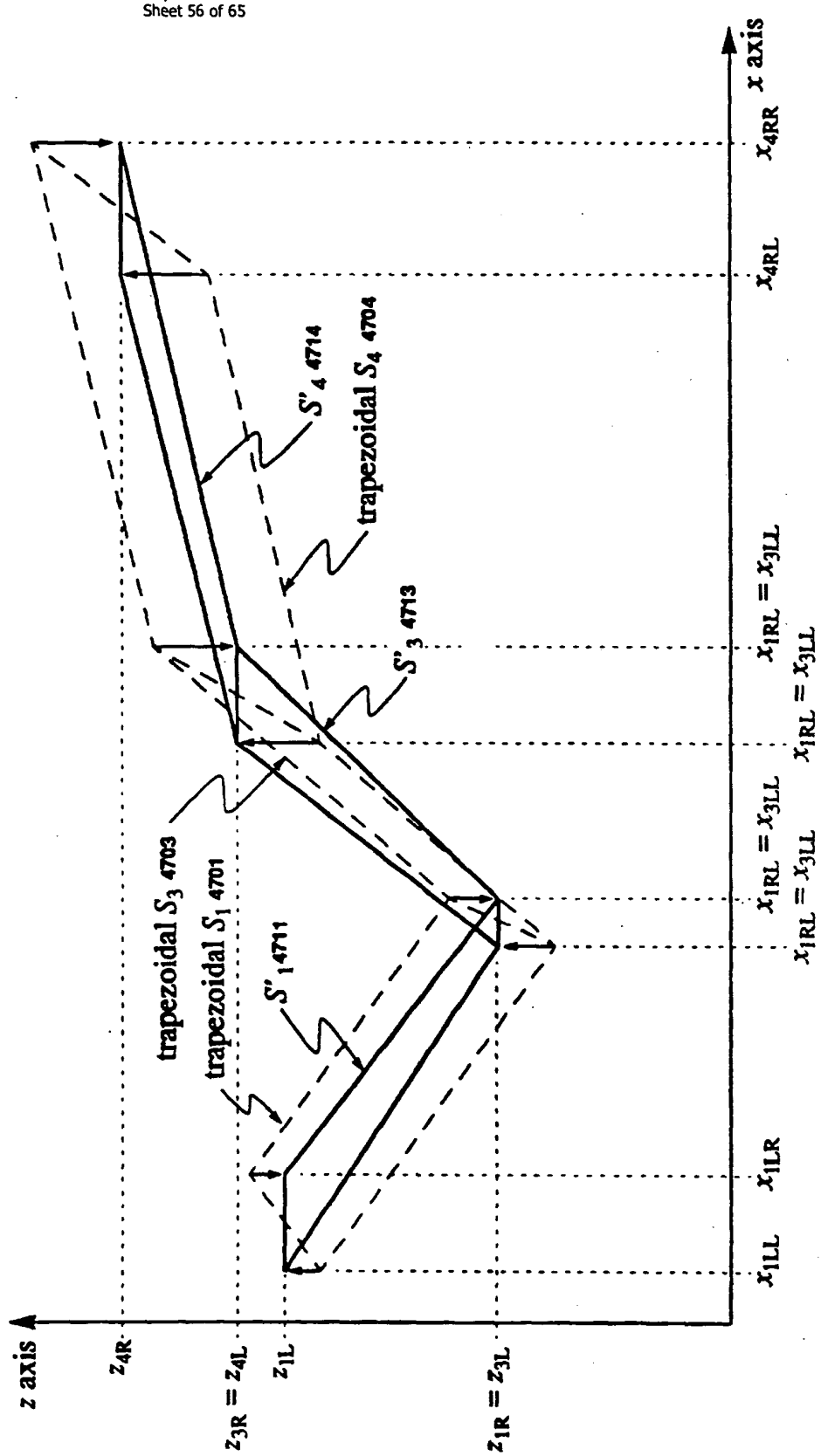


Figure 47 Using One *z* Value per Span Endpoint makes Quadrilateral Spans

Figure 48 A Set of Quadrilateral Spans on one Raster Line

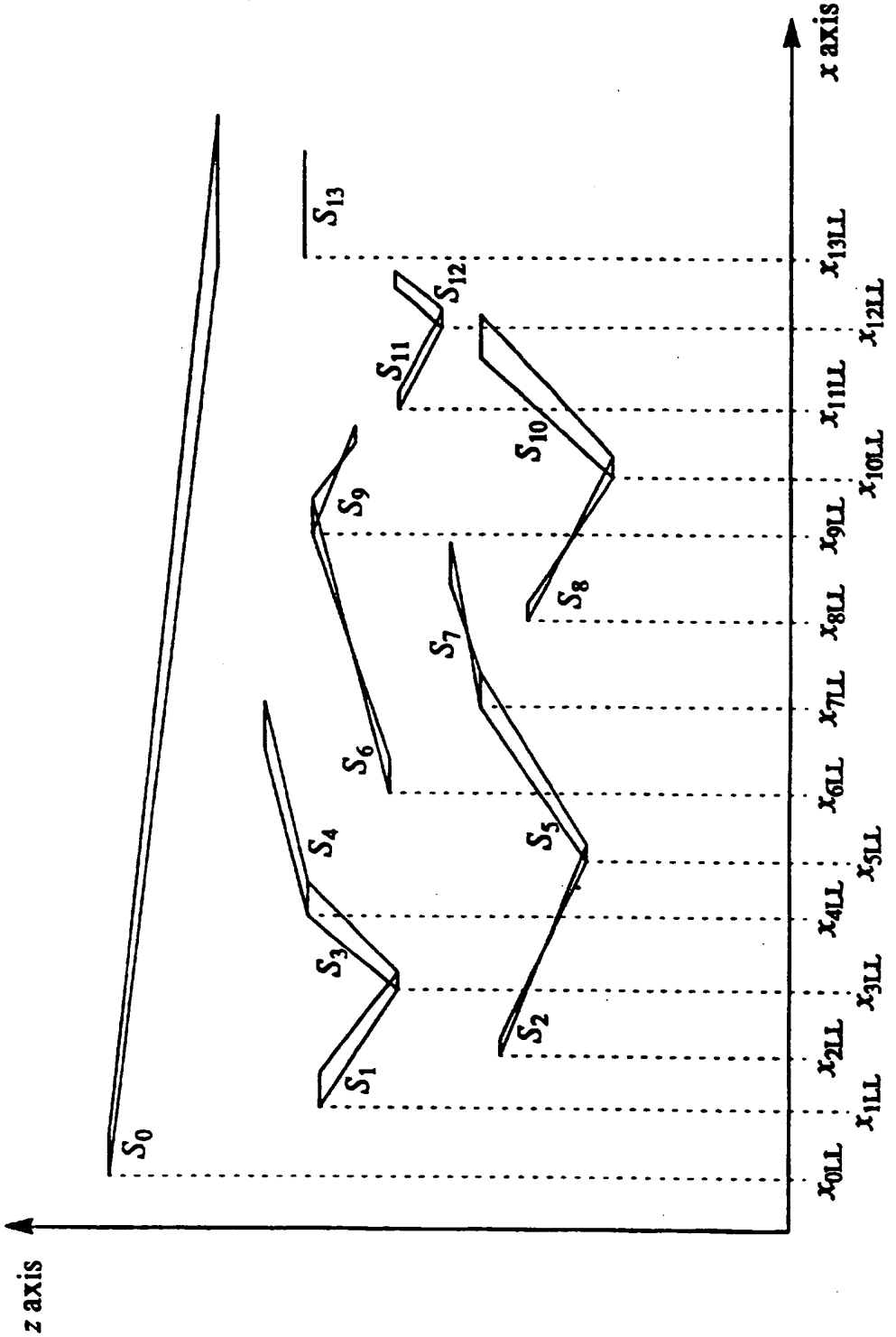


Figure 49 Span Sorting Rendering Pipeline with Direct Span Generation

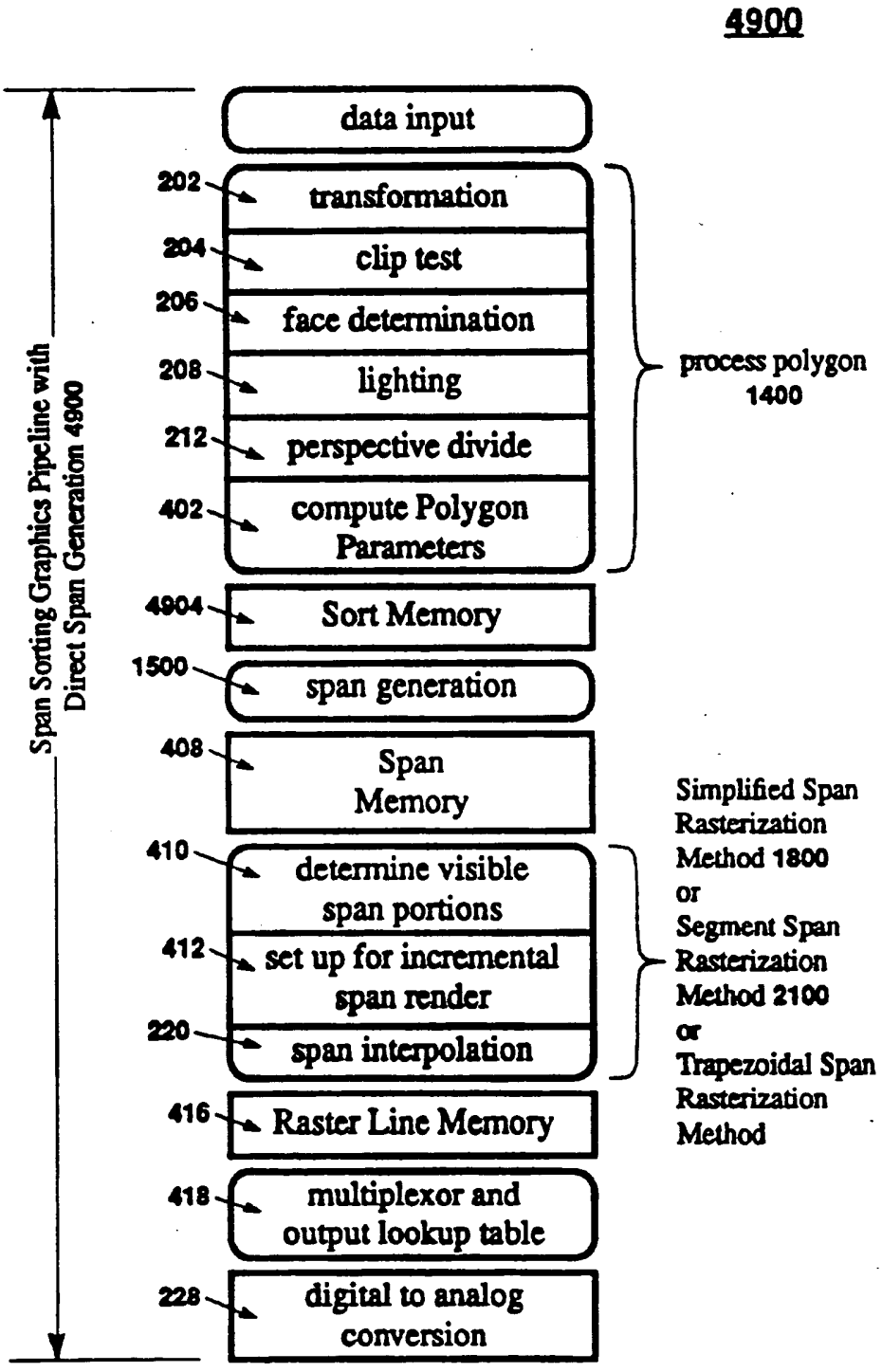


Figure 50 Span Sorting Renderer Architecture with Direct Span Generation

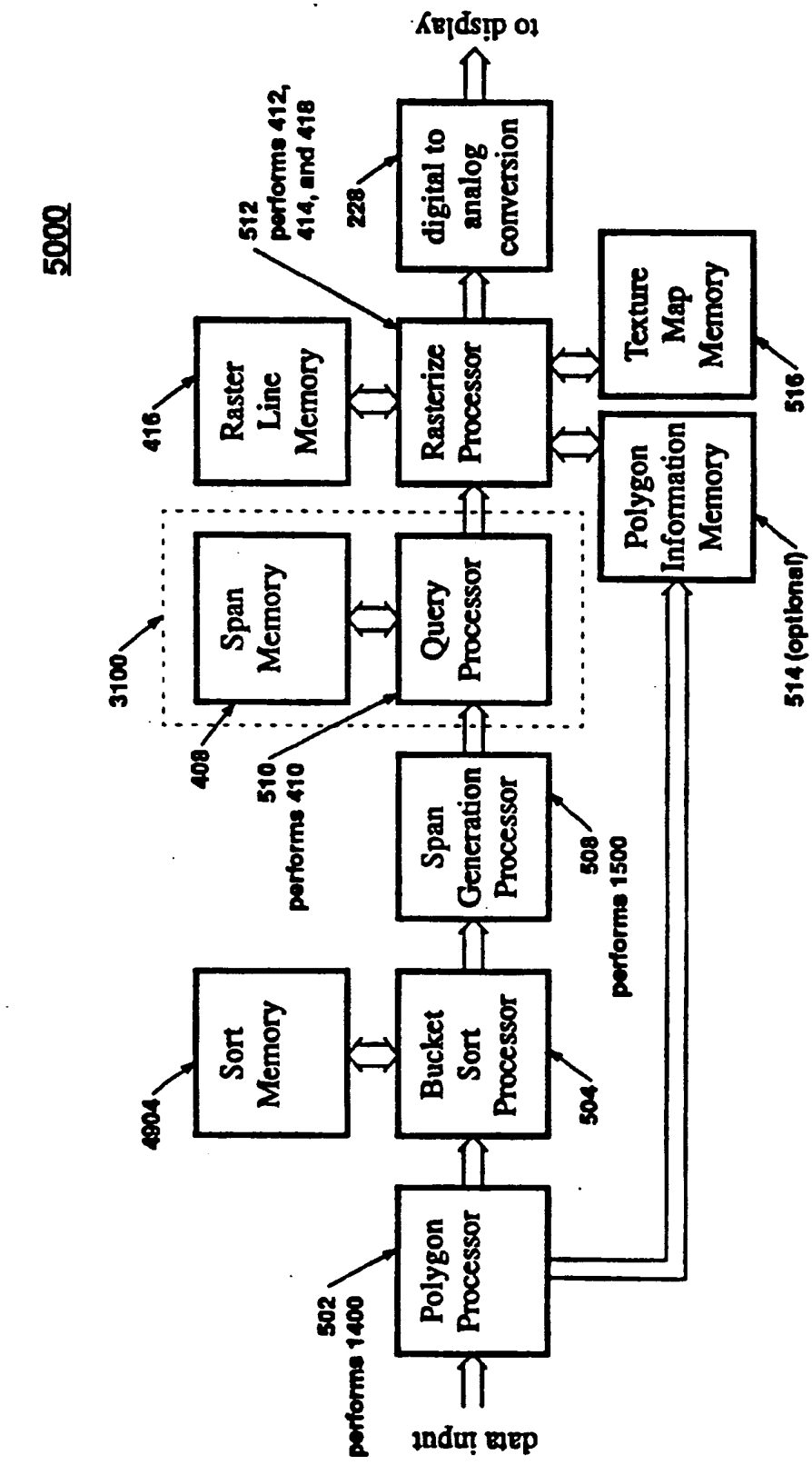
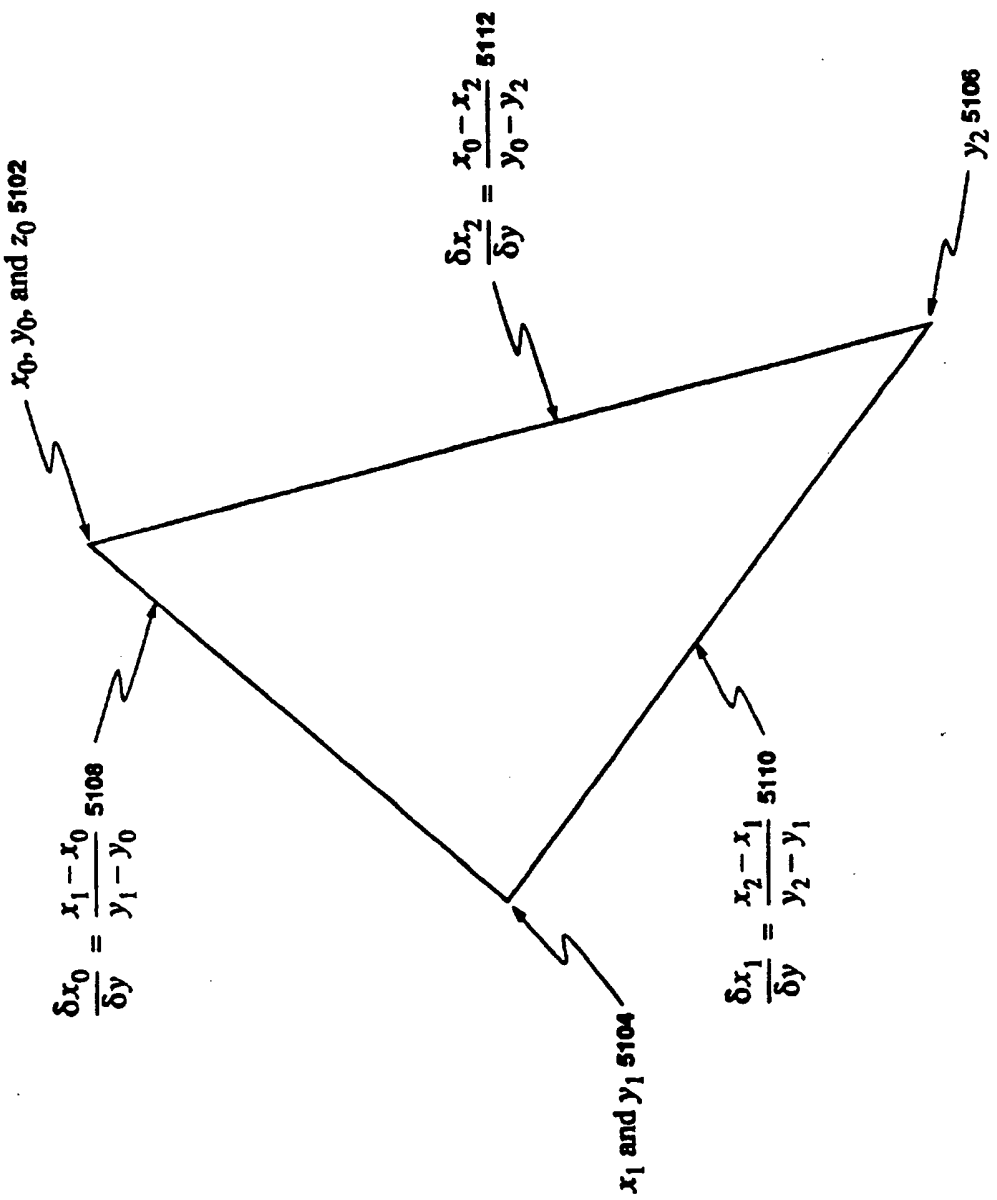


Figure 51 An alternate set of Polygon Parameters as Stored in Sort Memory



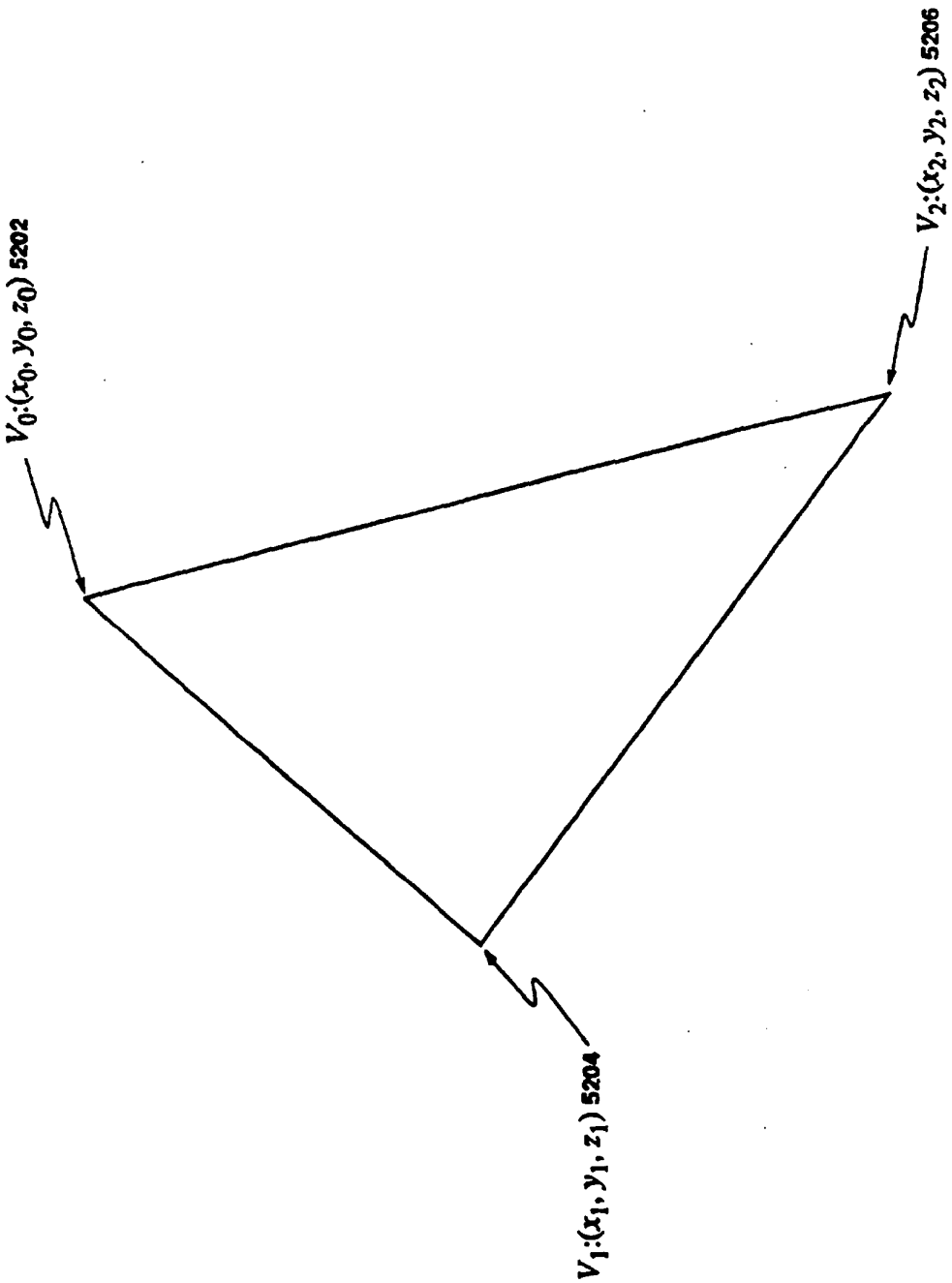


Figure 52 Generic Triangle Parameters

Figure 53 An Alernate Span Representation as Stored in the Span Registers

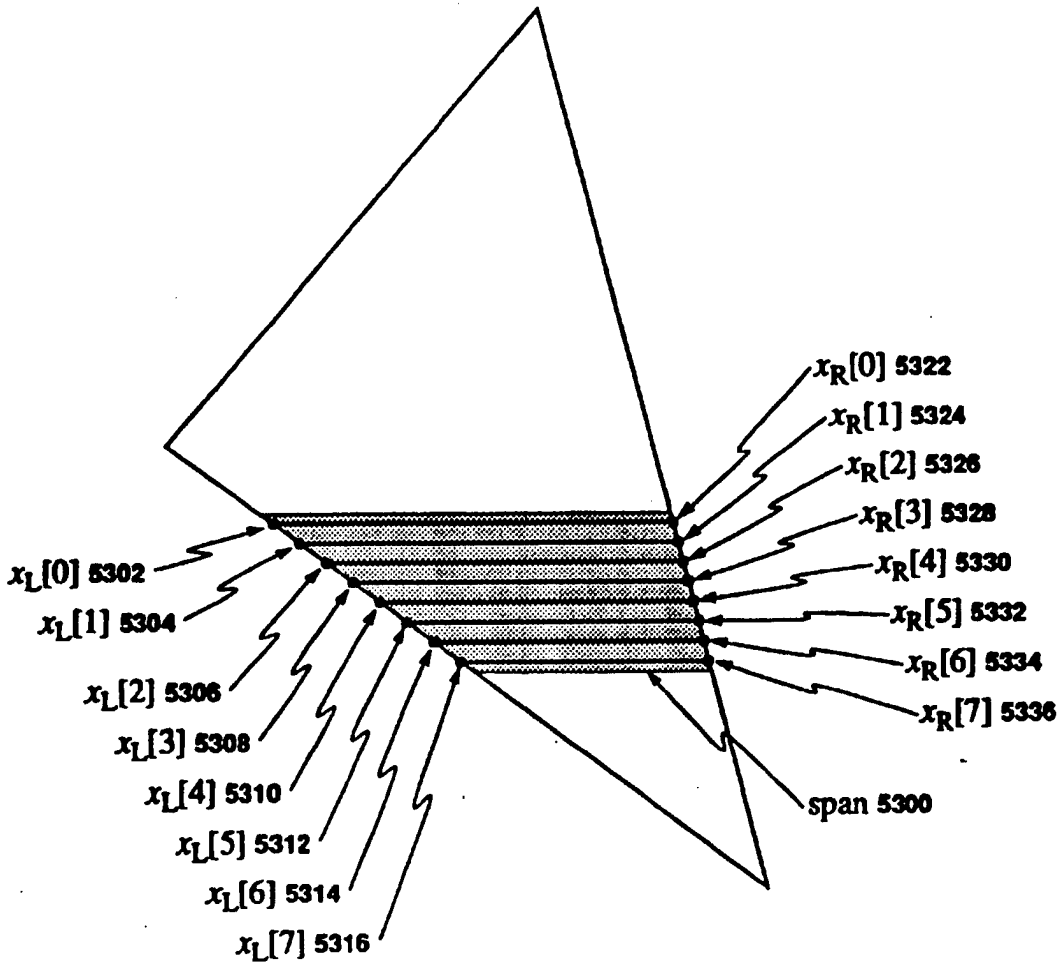


Figure 54 An Alternate Span Representation as Sent to the Rasterize Processor

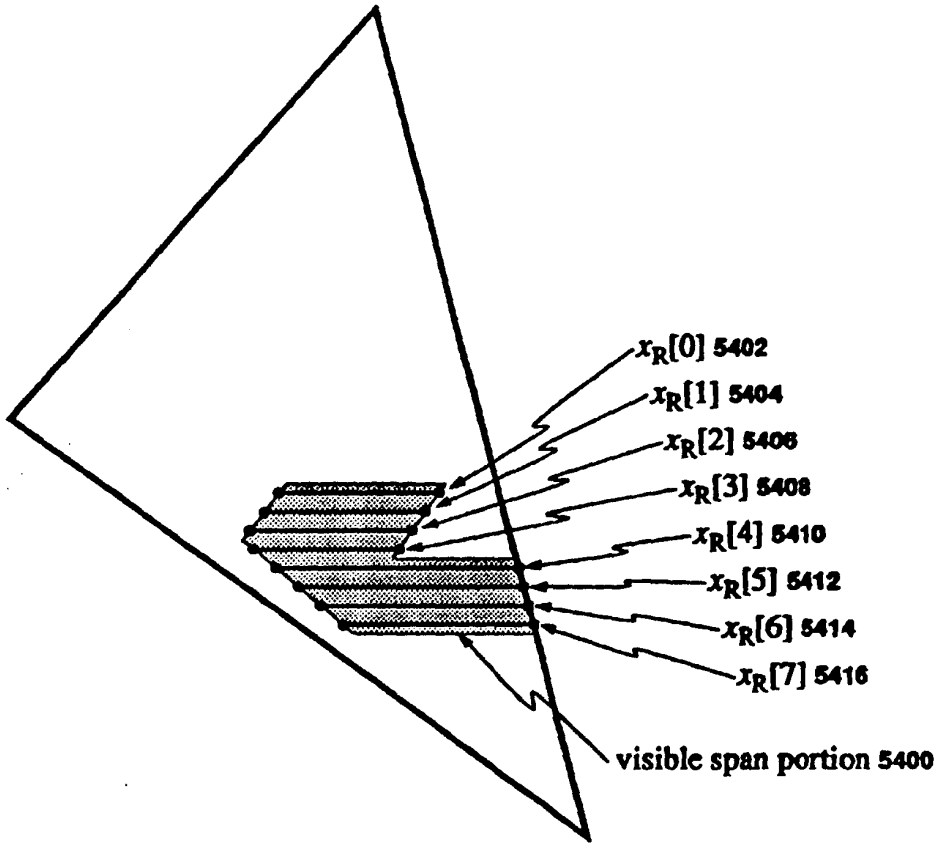
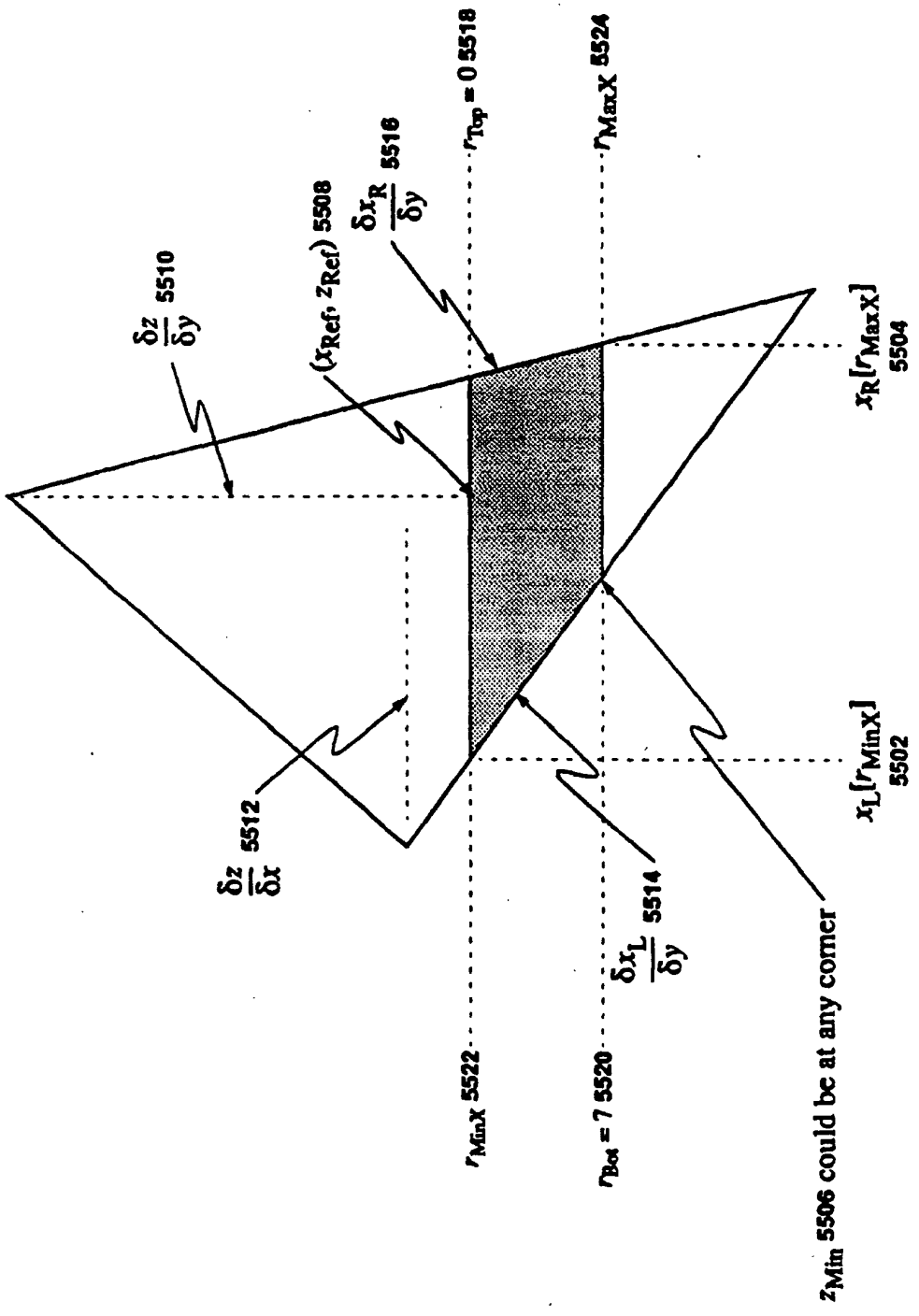


Figure 55 An alternate set of Span Parameters as Stored in Span Memory



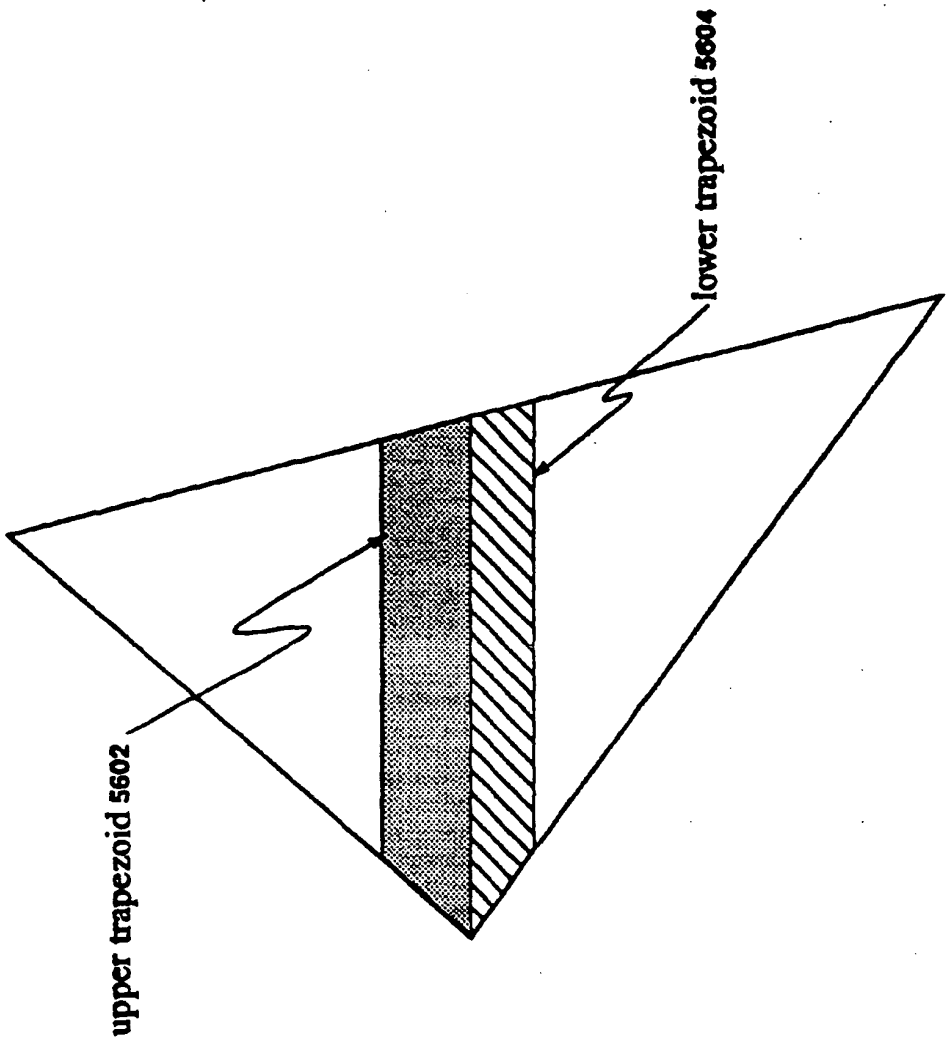


Figure 56 Trapezoidal Spans when a Corner is Included